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JOURNAL OF MICROSCOPY

AND

NATURAL SCIENCE:

THE JOURNAL OF

THE POSTAL MICROSCOPICAL SOCIETY.

EDITED BY

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Honorary Secretary of the Postal Microscopical Society;

ASSISTED BY

SEVERAL MEMBERS OF THE COMMITTEE.

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Preface.

THE completion of the Second Volume of the New Series of the JOURNAL OF MICROSCOPY AND NATURAL SCIENCE calls for a few words in acknowledgment of the valuable assistance we have received during the past year, and the expression of our hopes that such kindly aid may be continued during the coming year.

For ourselves, we confidently rely upon the numerous promises of aid we have received from microscopists and others to enable us to maintain the high character the Journal has attained for the publication of Articles of increasing merit, and hope that during the coming year we may be enabled to place before our readers papers of greater excellence and more general interest than in the past.

We must ask our readers to assist us by transmitting notes of matters interesting to fellow microscopists as well as by personal recommendation. On our own behalf, we undertake that no trouble or expense shall be spared to render the JOURNAL OF MICROSCOPY worthy the assistance and support its numerous friends so freely accord it, and to commend to our readers our motto—

"KNOWLEDGE IS NOT GIVEN TO KEEP, BUT TO IMPART."

THE

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"*Knowledge is not given us to keep, but to impart: its worth is lost in concealment.*"

The Presidential Address.

By Edwin Bostock, F.R.M.S.

It is by your good pleasure that I am called upon to occupy the position of President of the Postal Microscopical Society for the year we are just commencing, and I beg to return you my most cordial thanks for the great honour you have thereby conferred upon me; but I regret at the same time, upon your account, that your choice has not fallen upon some other member of our Society, possessing greater leisure and better qualifications for the post.

As a true lover of Nature under all her aspects, and more especially as manifested in those minuter forms of life that call for the use of our favourite "tube" in their investigation, but living in a remote country town where frequent intercourse with fellow-workers is unattainable, and a microscopist is a sort of *rara avis in terram*, I find myself situated amongst the ranks of those to whom our Society affords a welcome help and stimulus by bringing us in contact with the thoughts and actual labours of other workers. So, with your kind permission, I propose this evening to make a few remarks that have occurred to me in connection with the working of our arrangements.

I think we may fairly congratulate ourselves upon the marked improvement in the character of our boxes resulting from the alteration of the Rules, whereby each member is called upon to contribute from six to twelve slides simultaneously, together with accompanying notes, for instead of a heterogeneous collection of unconnected slides as heretofore, we have now, for the most part, connected series bearing upon one and the same subject, which thus receives a much fuller elucidation than was otherwise possible, and is more calculated to elicit notes of greater value. As regards these, however, there still seems to be much to be desired, for while according a full meed of praise to the excellent notes and admirable drawings that accompany a number of the boxes, there are frequently others with which they are of a very meagre and insufficient character, or sometimes entirely omitted, such boxes making the round of the various circuits without either giving or acquiring much information that is of any value—for the three evenings allowed to each member for the examination of the slides and the addition of notes must necessarily be very insufficient, where members like myself have their time usually fully occupied. It may, then, be worth while to consider whether this state of things may not be in some measure obviated.

Having had occasion to visit Bath (the headquarters of our Society) at the commencement of the present year, I took the opportunity to suggest to our excellent Secretary what appeared to me as likely to lead to a considerable improvement in this respect, viz., the formation of what may be called "Correspondence Circles" amongst our various members, whereby such as are working at the same or allied subjects should be brought into communication with each other, irrespective of the ordinary circulation of slides as at present existing. The work of each member should be submitted to the other members of their special circle for comment and friendly criticism, and by judicious questions and replies a much larger amount of valuable information would be elicited than seems to be at present practicable.

The result of these various discussions would go to furnish the Note-books of the Society generally, such portions as might appear desirable eventually finding for themselves a shrine in the pages of the Journal.

I was consequently much pleased to see this suggestion appear in the April number of the Journal much more fully elaborated and embodied in the form of a letter from "A Member," but the reception that it met with at the hands of our members seems to have been a very discouraging one, for I learn upon enquiry that *one* reply only was forthcoming—and that not from a member, but from a subscriber to the Journal only!

I am inclined to attribute this result not so much to the apathy of our members as to the over-elaboration of the scheme, and to think that, provided the "temporary correspondent," the "election of correspondent," and the "common fund," with divers others of the proposed regulations, were dispensed with, the various members who might be inclined to join the different circles would get quickly and unostentatiously to work, without involving our already over-wrought Secretary in further unnecessary labour.

That difficulties would arise in the practical working of such circles—judging from my own previous experience—there is little doubt; but few things of any value are to be accomplished without, and as these difficulties arise they might readily be solved by cordial co-operation and goodwill.

Leaving this question for what it may be worth to the consideration of members, I will turn for a short time to the subject of my own special work, with the object of enlisting the interest of some of our junior members, at any rate, in the study of Acarology, in which, although much has been already accomplished, there remains still very much more for diligent investigators to unravel, and, I take it, a section of our Society could be engaged in no better manner than in providing both facts and materials towards some future work upon any of the different families comprised in the Acarina of our country, for, with the exception of the admirable manual on "The British Oribatidæ," by my friend, Mr. Michael—the second volume of which has been issued by the Ray Society during the present year—I believe there is no other comprehensive work in the English language upon any of the other families. It is much to be hoped, however, that he may be induced to perform a similar service for the extensive family of the *Gamasidæ*, and so earn the further gratitude of all English Acarologists.

The families included in the order "Acarina" are divided into "Tracheata" and "Atracheata," and are as follows:—

TRACHEATA.

1.—Gamasidæ	Gamasinæ, with Pteroptinæ and Dermanyssus -	- Predatory Mites; Mites parasite on Bats and other Vertebrates.
2.—Ixodidæ, including Argas -	-	- Ticks.
3.—Oribatidæ	- - - -	- Beetle Mites.
4.—Trombidiidæ	- Tetranychi -	- Spinning Mites.
	Trombidiinæ -	- Harvest Mites.
	Bdellinæ - -	- Snouted Mites.
5.—Cheyletidæ.		
6.—Hydrachnidæ	- - - -	- Water Mites.
	Limnocharidæ -	- Mud Mites.
	Halicarinæ -	- Marine Mites.
7.—Myobiidæ	- - - -	- Louse Mites.

ATRACHEATA.

8.—Tyroglyphidæ	- - - -	- Cheese Mites, etc.
9.—Sarcoptidæ	- Analginæ, with Mycoptes and Listrophorus -	- Bird-Louse Mites.
	Sarcoptinæ -	- Itch Mites.
10.—Arctisconidæ	- - - -	- Water Bears.
11.—Demodicidæ.		
12.—Phytoptidæ	- - - -	- Gall Mites.

It may possibly be useful to indicate some of the localities where the various families may be found.

The members of the *Gamasidæ* are usually active and predatory, ranging about free in damp places, in moss and under stones, while in the nymphal condition large numbers may often be found upon beetles, such as *Geotrupes stercorarius*, etc., and upon the various hybernated *Bombi.* They have filiform palpi, and in *Gamasus* the first pair of legs are usually tactile organs, while the second pair in the males are often swollen and enlarged, and provided with singular appendages and hooks. This is a very marked feature in *G. terribilis*, which is usually met with in moles' nests. The spear-shaped mandibles with which the males are armed are used by this creature for thrusting through its prey.

The *Pteroptinæ*—which are easily distinguished by their short, thick, conical legs, the first pair of which are holding-organs—are found upon bats. The bristles and hairs, with which they are liberally provided, are jointed in a similar manner to the hairs of the bats themselves. *Dermanyssus avium* is well known upon our cage-birds, and is a frequent inhabiter of our poultry-houses.

The second family, or *Ixodidæ*, contains the largest-known representative of the order, the female of *Ixodes Ægyptius* attaining the dimensions of one inch by three-quarters. Some specimens from Rorke's Drift, in my possession, are fully seven-eighths of an inch in length. Their rostrum is composed of two lateral parts, or valvate palpi, sheathing the middle part, which is covered with recurved barbs, which prevent its extraction when once driven into the flesh. They may be met with in woods and herbage, but more frequently upon animals, to which they have attached themselves for the sake of a more liberal diet. From all accounts, however, they appear able to endure long privation. Some specimens of *Argas reflexus*, sent me from Canterbury a year or two ago, continued alive and active after being incarcerated some six months in an empty pill-box.

The number of known English species is not large, but the deficiency is fully made up in foreign countries, where some of them have evil reputations on account of the poisonous nature of their bite. The *Argas Persieus* was figured in Eastwick's "Journal of a Diplomato's Three Years' Residence in Persia," and he there describes the novel cure prescribed at Meshed for its bite. A servant of his underwent it. The patient goes to a house where bowls of curds are served out to him. After having drunk the contents, he sits down upon a seat suspended by ropes, which is then spun violently round until it acquires the motion of a top. The effect of this acting upon the curds is to produce vomiting to such an extent that sea-sickness is a pastime to it. The patient faints, but it is said most frequently recovers !

The *Oribatidæ* constitute the next family, and as regards these I cannot do better than refer you to the work before mentioned. The investigation of their life-histories and the observation of their habits will amply repay anyone devoting attention to them, and there are some points in their economy that are still uncer-

tain ; but as regards the discovery of new forms, so fully has the work been carried out, that at the best nothing but gleanings can be expected by future investigators.

The next family, or *Trombidiidæ*, contains three sections :— The *Tetranychi*, or Spinning Mites ; the *Trombidiinæ*, or Harvest Mites ; and the *Bdellinæ*, or Snouted Mites.

The first—which are distinguished from their congeners by their semi-transparency, paler colours, and smaller size, as well as by their chelate palpi—includes the "red spider" of our gardens, and at times assume a serious economic aspect. Gardeners know only too well the results of their ravages in hot-houses, and I have seen fruit-trees completely ruined by their attacks. The discomfort and irritation occasioned by *Leptus autumnalis*, another member of this family, is too well known to need any description.

The *Trombidiinæ* have much more brilliant colouring, generally scarlet or some modification of red. They are found upon the ground or under stones. They have raptorial palpi, and are, without doubt, predaceous and carnivorous. The *Bdellinæ* are met with in similar situations. They have much the same character of colouring, and are distinguished by the mouth-parts projecting like a snout, which, being usually narrowed behind the palpi, gives them the appearance of having a head and neck. This is further indicated by the antenni-form resemblance of the palpi. The *Cheyletidæ* are found in company with other acarids, upon which they feed, and are distinguished by their enormous, rapacious palpi. They may be found in collections of chaff, old hay, meal, flour, etc., and are generally distributed. They number amongst themselves the somewhat unique case of a parasite that is beneficial to its host—*C. parastivorax*—living in the fur of rabbits, where it feeds upon other acari, with soft bodies, such as *Listrophorus*, etc.

The sixth family—or *Hydrachnidæ* (amongst which our friend, Dr. George, has done such good work), together with the *Limnocharidæ*, or Mud-Mites—have what are called "anchoring palpi," which are provided with hooks, whereby they can attach themselves to other objects. They are mostly of bright colours, and are considered as *Trombidii* modified to suit the element in which they live. The first have legs adapted for swimming, and are

found both in ponds and running streams. The latter crawl slowly over the mud and weeds, and constitute the link between the *Trombidii* and the *Hydrachnidæ.* The *Halicarinæ* are chiefly marine, and may be met with in numbers in the sea-weeds of our coasts from low to high water-mark and even above, where the waves sometimes reach. In colour they vary from white and black to red.

The next family, *Myobiidæ*, are found upon the fur of rats and mice and other small mammals. Their styliform rostrum doubtless enables them to draw upon the juices of their host, while, with the singular, twisted, clasping apparatus, provided on the first pair of legs, they cling firmly to their hairs. *Musculus* is said chiefly to affect the head and shoulders of the common mouse; but, so far as my experience goes, it is equally spread over the whole body. Upon the rat they are usually quite as numerous; but I have my doubts as to whether these are not another species, the females differing in the character of the abdominal hairs as well as in other ways.

To this family belongs that interesting genus, *Disparipes*, sometimes found in considerable numbers upon the various *Bombi* and also upon the nymphs of *coleoptratorum*, with which these are infested. They are provided with large, sickle-shaped claws upon the first pair of legs, by which they hold on grimly to the hairs of the bees or of their parasites. There is little doubt that other species may be found belonging to some of the smaller bees, if carefully sought for when opportunity occurs. *Pygmephorus* will rightly find its place in this family. It may frequently be found in some numbers clinging to the hairs of the thoracic spiracles of *stercorarius.*

It would carry me much beyond the limits of my address, and I fear of your patience, were I to do more than glance at the remaining families, which constitute the Acari proper or the Atracheate group of the *Acarinæ.*

Suffice it to say that in the *Tyroglyphidæ* we get that peculiar and interesting phase of mite-life, known as the Hypopial stage, wherein certain individuals assume temporarily entirely different characters from the ordinary nymph, and by attaching themselves to other creatures are carried to "fresh fields and pastures new,"

where they re-assume their previous condition of nymph, complete the cycle of their development, and give origin to new colonies.

The *Sarcoptidæ*, or Itch Mites, forming the next family, include the *Analginæ*, or Bird-Louse Mites, a singular and very imperfectly worked-out group. Living amongst the feathers of birds, and feeding upon the effete matters falling therefrom, they probably cause little or no inconvenience to their hosts. The forms are both varied and remarkable, especially upon some foreign birds, and they offer a large and interesting field of study to any microscopist inclined to enter upon it.

The *Sarcoptinæ*, or Itch Mites proper, are not an inviting subject, or one upon which I can any longer dwell, beyond remarking that I have but rarely met with any single rat in which the ears were not infested with *Sarcoptes mutans*, a form closely allied to *scabiei*.

The *Arctisconidæ* and *Demodicidæ* present few points of general interest, so with a passing reference to the last family of *Phytopti*, I will now close. They are found upon the leaves of various trees and plants, producing excrescences of different forms and characters. It is uncertain whether they are miniature forms of *Tetranychi* or not. And here we have another field for investigation well worthy of being worked out.

If by directing attention to these small creatures any of our members are led to take a greater interest in the subject of my address, they cannot fail to derive much pleasure and instruction from the investigation of their habits and modes of life, or to be struck by the marvellous variety and perfection impressed by the hand of the Creator upon these minute living atoms!

THE COLDEST REGION.—According to the Russian meteorologists, the coldest spot yet found upon the earth is Werchojansk, in Siberia, where an observing station of the government has been established. The mean temperature there, for the year 1885, was 2·9° Centigrade below zero. For the month of January of that year it was 62·9C. below zero, but for July it rose to 60·6C. above zero. The lowest in July was 39·2C. above zero; and in January the thermometer fell as low as 88·6C. below zero.

The Nutritive Processes in Saccharomyces.

By Henry C. A. Vine.

Plate I.

THE writer has been asked to embody, in a definite form, some observations on this subject, made before the Bath Microscopical Society: he has felt great hesitation in so doing, as the subject involves many points of controversy, into the discussion of which his want of leisure forbids him entering.

The actual nature of the processes of nutrition in the *Mucorini*, the *Schizophytes*, and the *Saccharomycetes*, have not, so far as the writer is aware, been the subject of any special research. The nature of the materials on, or in, which they flourish, and the results of their vitality, are well known, and the knowledge is made subservient to the wants of everyday life, as in the manufacture of wine, beer, and bread. In fact, the decomposition of saccharine matter (carbo-hydrates) and the evolution of alcohol and carbonic-acid gas by the action of minute fungi is among the earliest lessons of the physiological student. But meanwhile we remain ignorant of the exact manner in which these organs assimilate their food, and of the precise condition in which it is necessary for it to be presented to them.

For such studies the *Saccharomycetes* appear to present the greatest facilities, being readily obtained in a fairly uniform condition, and being from their size readily separated to a sufficient degree from more minute organisms. The *S. vini*, *S. cerevisiæ*, or the *S. Pastorianus* would equally serve our purpose, but the *S. cerevisiæ* is in all ways the most convenient, especially as the amount of knowledge concerning this species already in hand greatly facilitates investigation. It comprises several distinct varieties, which, as long as the cultures remain pure, retain well-defined characters. The shape of the cell, the structure of the cell-wall, and the nature of the cell-contents, all present definite points of difference, and call for a greater amount of classification than they have yet received.

The study of their nutrition may be conveniently made under

two heads :—(1) As to the nature and condition of the nutrient material; and (2) as to the manner in which such nutriment finds its way within the organism.

As regards the first, it has been repeatedly shown by well-known investigators that various species of Saccharomycetes will grow, and to some degree thrive, in media other than the saccharine fluids in which they are properly found; indeed, that they *can* be cultivated in solutions containing mineral salts only. This leads at once to the conclusion that whatever absorption of other materials may be going on, the cell-wall must necessarily be pervious to certain inorganic salts, which, it should be noted, are of course crystalloids, and therefore capable of passing the membrane of a dialiser.

Following up the indications thus obtained and cultivating specimens of healthy *S. cerevisiæ* in infusions of malt containing various amounts of ammonia or nitrogen salts, certain fairly definite differences in the results may be observed. These cultures can be conveniently made in test-tubes plugged with cotton wool and containing nutrient liquids carefully sterilised, and the deposit of cells should be examined under a power of not less than one-tenth inch. The examination of a number of such cultivations will show that the vigour of the cell and the process of multiplication is visibly increased by the mineral additions, though not always with regularity.

On making similar cultures of pure cells in solutions of cane sugar, with and without the addition of nitrogen and ammonia salts and alkaline phosphates, one finds that although the vitality of the cells is *maintained* in the solutions of sugar only, yet that it is with difficulty that the cells do not increase and that the vigour of those remaining visibly declines. If these cells be now placed in a fresh sugar solution, they will exert but little decomposing action, and their vitality will come to a standstill. But if they be now removed to a weak malt infusion (containing, besides saccharin matter, albuminous and other nitrogenous compounds, and some mineral salts), or to a solution of sugar containing nitrogen, salts of ammonia, and potash, with some tartrate of ammonia, they will rejuvenesce, so to say. The cell-contents will again fill up the cell. The outer wall will recover

some of its symmetry, and the process of multiplication will recommence and will continue according to the suitability of the cultivating medium. We find, then, that in solutions containing carbo-hydrates alone, the cell is scarcely able to survive, and its power of propagation is lost; while in media containing nitrogen compounds the opposite conditions generally maintain.

The next step is to learn something of the character of the nitrogenous matters which produce this effect. It has been seen that crystalloid nitrous compounds are capable of sustaining the vitality of the cell, and that organic liquids, such as malt infusions, are equally or better suited to the same purpose. It remains, then, to ascertain whether, if any crystalloids present in the organic infusions be removed, the liquid will still be as capable of sustaining life. The writer first experimented with liquids containing nitrogen in uncrystallisable form only, but although the results were fairly definite, the method seemed scarcely so satisfactory as cultivating in an organic infusion from which crystallisable nitrogen could be removed. In order to do this, a malt infusion was submitted to the action of a dialyser, under suitable precautions, to prevent putrefactive or fermentative changes, and the crystalloids were thus almost entirely abstracted from the liquid. Comparative experiments were at the same time made on liquids having a known amount of nitrogen crystalloids of as nearly as possible a similar character.

With proper precautions, cultivations were attempted in the dialysed liquid, and on the second and third days the deposited cells were examined. The appearances presented were closely analogous to those of cells grown in solutions of sugar only, although scarcely so definite. An attempt to carry the cultivation further was unsuccessful, owing to the difficulty of avoiding putrefactive changes, but enough was gained to indicate that the withdrawal of the crystallisable nitrogen rendered the liquid unfit to maintain the vitality of the cells for any time.

To investigate the precise nature of these nitrogen bodies would involve chemical research beyond the limits of the present article. The writer is inclined to think that when such research is undertaken it will be found that compounds of an amide character play an important part, and that the suitability of a

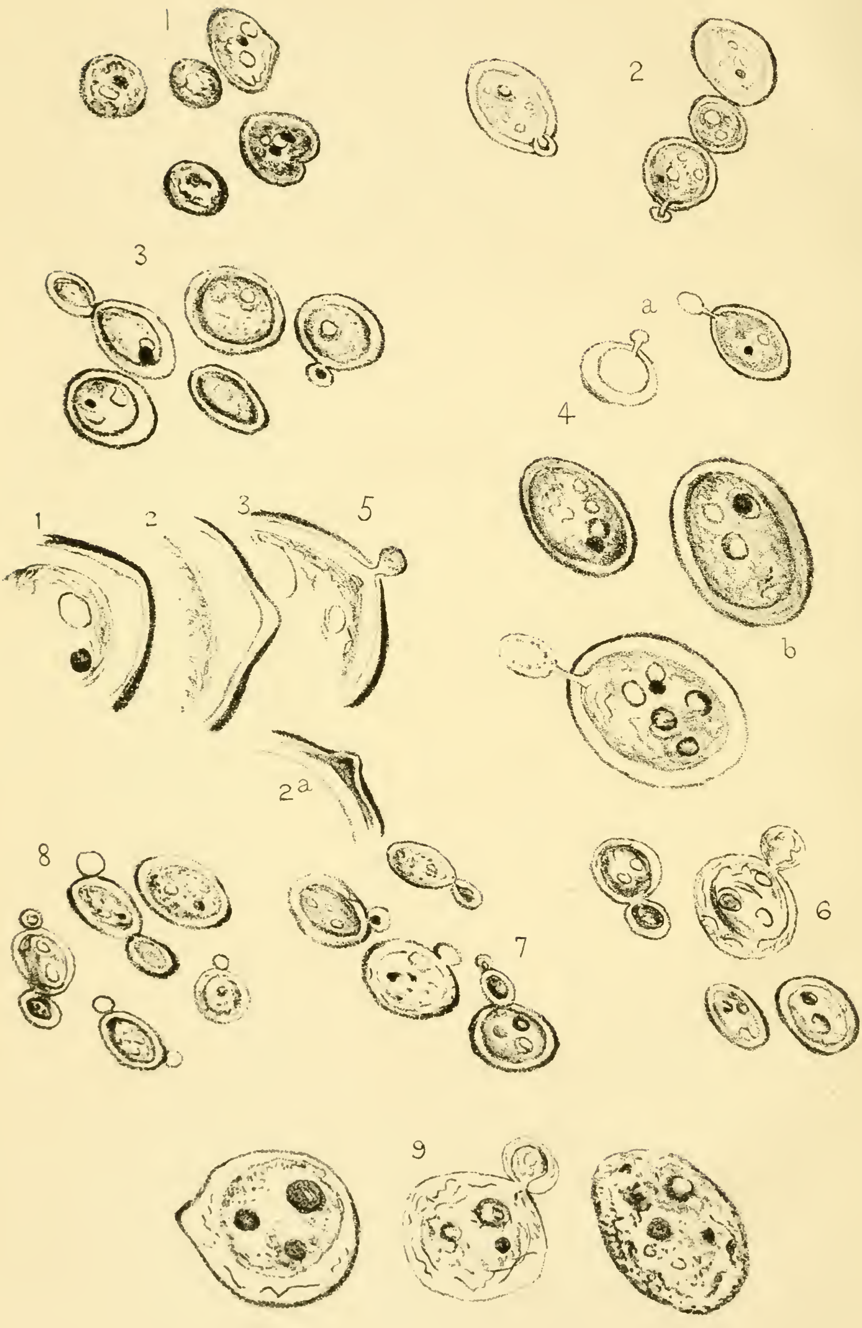
liquid as a nutrient medium for the growth of Saccharomyces depends much on the amount of resolution in this direction which the organic compounds have undergone.

To come to the second point: *how* the nutrient material enters the organism. It has been suggested that the cell-wall may consist of layers of molecules, in which the individual molecules are so joined together as to constitute a membrane infinitely full of interstices due to the inexact adaptation of the constituent parts to each other, and that a series of layers, such as would constitute the cell-wall, would form a more or less spongy envelope permeable by substances whose molecular constitution was sufficiently minute. The writer is not disposed to argue the tenability of such an hypothesis, but the examination of numerous cells in process of budding, under high magnifying power, has shown that the manner of this production of the buds from the parent cell is not incompatible with such a theory.

To facilitate these examinations, various efforts were made to stain the cells in such a way as to differentiate the layers of cell-wall and the cell-contents without inducing, at the same time, any physiological changes of importance.

The most satisfactory results were produced by the action of methyl-violet, which appears to penetrate and colour the protoplasmic mass, and to slightly dye the cell-wall. But when cells thus coloured are well washed in distilled water and transferred to a stain of aniline green for some hours, it is found that, in some instances, the violet has only coloured the *inner* membrane of the cell-wall, the outer layer having taken a slight green colour, which enables it in favourable cells to be clearly made out.

Where cells in process of developing buds, or having young cells attached, have been thus double dyed, the observer is able to ascertain with a great degree of exactness the manner in which the budding takes place. It becomes clear that the distention of the cell-wall at one point at length stretches the outer membrane to such an extent that it becomes permeable to the mass within. But no sooner has a small portion of the lining membrane or the cell-contents found its way through, than the outer coat, relieved of the pressure, closes by its elasticity around the protruded portion, and causes it to assume the form of a globule, having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only a very narrow channel of communication with the parent protoplasmic mass.

From the nature of this process, it is evident that the enveloping membrane is possessed of both elasticity and porosity, varying, no doubt, according to the character of the environment.

Having demonstrated that the cell-wall is not the hard and shell-like mass that it would at first sight seem to be, the observer experiences little difficulty in realising that it may be readily permeated by nutrient material presented in suitable form, or further by excretitious matter, the retention of which would be injurious.

EXPLANATION OF PLATE I.

Fig. 1.—*Saccharomyces cerevisiæ*, cultivated in a solution of cane sugar.
,, 2.—Cells of the same, as seen under 1/10-in. immersion objective
,, 3.—*S. cerevisiæ*, cultivated in a solution of cane sugar with ammonia tartrate and ammonia phosphate.
,, 4.—Cells stained with methyl violet and aniline green, under 1/10-in. objective : (*a*) No, 1 eye-piece ; (*b*) No. 3 eye-piece.
,, 5.—Production of a bud by parent-cell.
,, 6.—Cultivation in malt infusion alone.
,, 7.—Cultivation in malt infusion with ammonia salts.
,, 8.—Cultivation in malt infusion with more of the ammonia salts.
,, 9.—Typical cells of *S. cerevisiæ*, 1/10 objective, No. 3 eye-piece.

Fresh-Water Sponges.

Mr. Potts, of the Philadelphia Academy of Natural Sciences, states that the order *Spongidæ* has many more representatives in the fresh waters of America than has generally been supposed. He recently described before the Academy three species of *Spongilla*, which he detected in a small stream near Philadelphia. Since then he has found the *Spongilla fragilis*, of Leidy, plentifully in the Schuylkill, below the dam, and a lacustrine form above the dam, and has obtained a very slender green species, which appears creeping along stems of *Sphagnum*, etc., in a swamp near Absecum, New Jersey, a beautiful species from the Adirondack lakes, another lacustrine form from the lake near the Catskill Mountain House, and four species from an old cellar at Lehigh Gap, Pennsylvania.

Microscopical Imagery.

BY DR. ROYSTON-PIGOTT, M.A., F.R.S. Plate II.

WHEN an object has been universally studied for half-a-century without any clear conclusion as to its structure, either a strong bias may be suspected or imperfect instrumentation, or feeble powers of observation.

A familiar example is that much-vexed question, the markings on such diatoms as *Formosum*, *Angulatum*, *Rhomboides*, etc. etc. Fifty years ago they were called *lined* objects, from their appearance under Ross's famous "quarters" giving 500 diameters. I could only get lines. Topping and others showed me the same appearances. It was not until I gave Powell and Lealand a commission to form for me three of their best glasses—¼, ⅛, and 1/16—regardless of expense, that a spherical structure appeared which astonished me exceedingly, *the lines* having entirely disappeared. The next question arose, If the beads are hemispherical, can they form optical positive images? Having worked on this question for many years, I now beg to present to our readers some of my results.

I recommend to students patient practice on the images formed by beetles' eyes (winged creatures' eyes fail to give the proper images).* Everyone knows they are hexagonally formed, like a honeycomb. I have succeeded on a clear day in displaying the miniature of a church-steeple 400 yards distant. Next, a minute hole, brilliantly illuminated, produces very striking positive images, formed between the eye of the observer and the eye of the beetle, as shown by delicate focussing. Its sidereal focus is about 1—600th of an inch, and lies above the convex surface, producing exquisite images of objects beyond. These simple facts demonstrate convexity in diatomic markings and the existence of spherical bosses.

A further advance in fine definition was attained by assuming that the cell, seen in coarse diatoms, is also spherically formed. My delight was extreme when the first miniature was descried. Minute apertures in front of a brilliant flame now gave gorgeous

* I am so informed by Mr. Hinton, who mounted for me a drone fly's eye, which gives no images at all. The beetle here alluded to is the common house cockroach.

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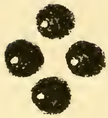

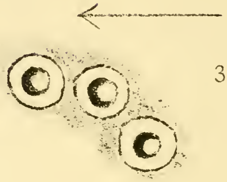

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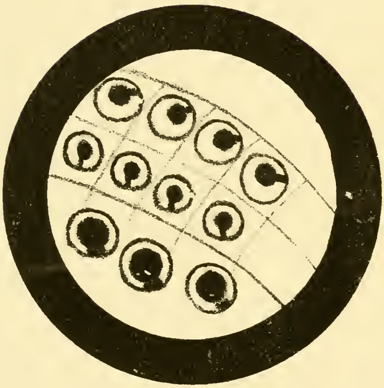

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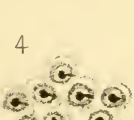

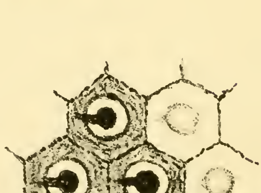

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Microscopical Imagery

effects as imaged by the diatomic bead. Here are a few examples. Fig. 1, central discs; Fig. 2, ex-centric; Fig. 3, others taken on the opposite side. All these images were found to be *above* the diatomic bead, proving it to be convex.

A more *réchérché* experiment is to exhibit the image of stops in either P. and L. condenser or Gillett's. These stops are supported by short arms, and vary in sizes, and produce intensely jet-black images amid a blaze of reflected light. Sometimes, a plane mirror only is used without a condensing lens, the movable stops rotating *in situ*, P. and L. having three only: Nos. 1, 2, and 3. The stops are ¼-inch, ⅓-inch, and ½-inch in diameter; the ¼ stop, as miniatured by the lens of a beetle's eye, appears about 1—5,000th of an inch in diameter.

But less difficult of manipulation is the mullion of a window 12 inches broad and about 130 inches distance. Each facet of the lens shows a vertical bar, whose thickness in imagery is easily measured by a good micrometer.* This mullion appeared 78,000 times smaller, and optically calculated gave a focal length of 1—600th of an inch. The facet lens is 1—1,000th of an inch across, and the refractive index 3/2, so that after all the animal possesses glass eyes! (The formulæ are too intricate for insertion.)

The 12-inch mullion† image, 120 inches distant, in a spherule of that splendid diatom, *Creswellii superba*, measured 1-60,000th of an inch. Consequently, the miniature is 1-720,000th smaller, and yet the mullion was distinctly visible, whilst the distance of the image above the convex surface was just 1—6,000th of an inch.

(*To be continued.*)

EXPLANATION OF PLATE II.

Figs. 1, 2, and 3.—Imagery of a minute illuminated hole below the condenser, shown with direct; and right and left oblique lights.

,, 4 and 5.—Images of a P. and L. stop of condenser, ¼ inch in diameter, as seen in large diatomic beads.

,, 6.—Beetle's eye, showing stop images in each facet.

* Mine, with 500, reads to two millionths.

† A vertical sash-bar, carrying the balance weights and cords.

Spider Gossip.*

Part I.

By H. M. J. Underhill.

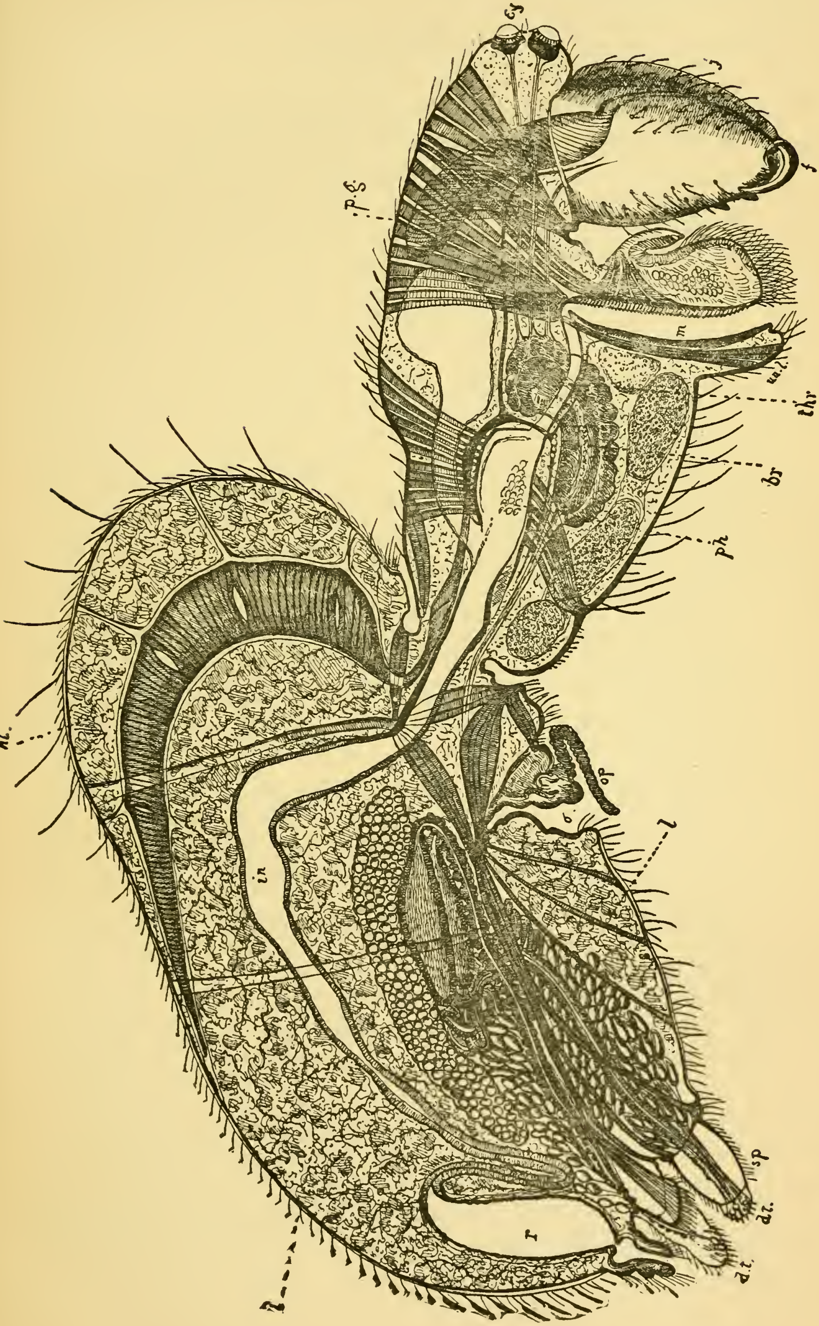
Plate III.

SINCE our nursery days we have all of us been more or less familiar with spiders. At the sight of one, few fair maids can quite overcome unpleasant sensations like those experienced by the celebrated Little Miss Muffet, and many a man avenges the heroic Tom Thumb's untimely death by squashing some unoffending spider as a "venomous little beast." Popular attention fixes on their venom and their webs as being the two most interesting things about spiders, and these are indeed the most wonderful things in a very wonderful insect. I say "insect" advisedly, for good authorities call it so, although, strictly speaking, spiders do not belong to "the class Insecta." When, therefore, we see a spider spin its web and kill a fly, and inquire, "How does she do it?" we ask a question of great scientific interest. So I propose to give some account in these papers of the way of working of these two functions, and to furnish besides some particulars of other parts of a spider's anatomy not less wonderful.

If anyone will catch a good big house-spider (which is difficult), or garden spider (which is easy), and, after killing it in methylated spirit, will carefully cut through the skin of the head behind the eyes, he will be able to draw away the spider's jaws with the poison glands attached. Care must be taken not to cut too deeply, because the glands lie just beneath the skin (see Figs. 1 and 6). A more satisfactory way of seeing them is to harden the spider in spirit, and then cut it into slices in a section machine. From slices cut in this way, I have drawn Pl. III.,† and most of the other illustrations of this paper. The scale of magnification is noted in the description of each figure, and all but No. 3 are magnified very moderately. As the magnifying

* From *The Welcome*, by special permission.

† In all further allusions to this Plate, it will be referred to as Fig. 1.



Longitudinal Section of Spider.

power in No. 3 is so much greater, I have marked four thousandths of an inch magnified to the same scale, to help the uninitiated to estimate the minuteness of the object.

The poison glands are like two little sausages; but they are hollow bags, containing fluid poison, and if one be crushed on blue litmus paper, the poison will escape and redden the paper. Thus we see that the poison is an acid—formic acid, I believe. Their sides are double, consisting of an inner skin of "epithelial" cells, which strain the elements of the poison out of the blood, and an outer skin of muscular fibres. This is well shown in the cross section, Fig. 6, and the spiral arrangement of the muscular fibres can be seen both in this drawing and in Fig. 1. The tightening of these fibres by contraction forces out the poison in front, just as the wringing of a wet cloth squeezes out the water at the sides. It goes, as Fig. 1 shows, down a long thin tube, through the jaw and fang, and is ejected from the latter through a tiny hole, a little space behind its point. This hole is too minute to be shown in drawings on such a small scale as Figures 1 and 4.

What a truly formidable weapon (to a fly) is a spider's jaw—even without the poison! Its solid basal joint is moved by powerful muscles situate in the head-thorax. A part of one muscle only is drawn in Fig. 1, because the others do not lie within the plane of the section. Then there is the keenly-pointed fang, sharper than the finest needle. This can be best seen in Fig. 4. In Fig. 1 the jaw is not drawn in section, like the rest of the figure, but in perspective, because I wished to show the tube connecting poison gland and fang, and this, like the muscles aforesaid, does not lie in the plane of the section. The fang is moved by muscles lying within the basal joint. The spider catches its prey by the leg or body; gives it an awful pinch; the sharp fangs go through the skin; and the poison is forced into the wound. Poor little fly! It is soon dead, and then its blood is sucked.

Now, this process is exceedingly curious. Underneath its fly-catching jaws, a spider has another pair, which, with the two lips, constitute its fly-sucking apparatus. They are shown in perspective, viewed from beneath, in Fig. 4, which also shows the under lip in the middle of the drawing. The two lips are drawn

in section in Fig. 1. These jaws cannot bite, but they are furnished with a pair of feelers, with which a spider may be observed to touch over its prey to see if it be good to eat. With the lips, they form a tube, down which the juices of the fly are drawn. The under lip is stiff, and has a hard, horny skin, but, as it has muscles, it is evident that it can be moved a little. The upper lip, on the contrary, is extremely mobile. Its skin is soft; externally it is furnished with a fierce moustache, and internally muscles traverse it in two directions. These can be seen in the illustration, one set as a *congeries* of little ovals, this being the

Fig. 2

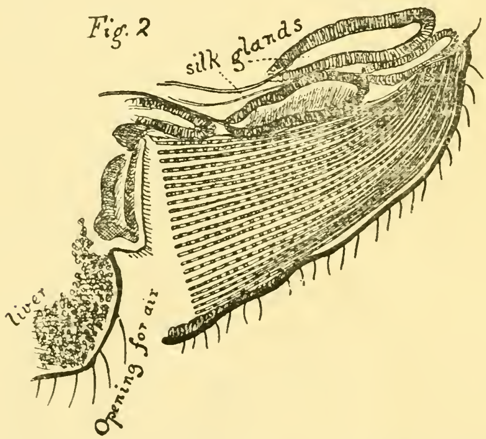


Fig. 2.—Lengthwise section of Gill or breathing organ of Garden Spider. The little black dots in the "leaflets" are blood cells. Magnified forty diameters.

form of the fibres when cut at right angles to their length. It is moved by strong muscles (also figured) arising from the top of the head and going right across it. Its most curious feature is the palate, or roof of the mouth. This is nothing more or less than a small and very finely grooved file. The roughness of its surface is indicated (in section) in the figure, but the individual ridges, small as they are drawn, are about six times too coarse. I imagine its use to be to grind down such parts of the fly as are too solid to be otherwise sucked in. When the spider sheds its

skin, both the palate and the throat come away too, and so its ridges are always being renewed and kept sharp. Passing through the mouth, the liquid food is drawn down the throat (*thr.*, Fig. 1 and Fig. 6). Its admission to the alimentary canal is controlled

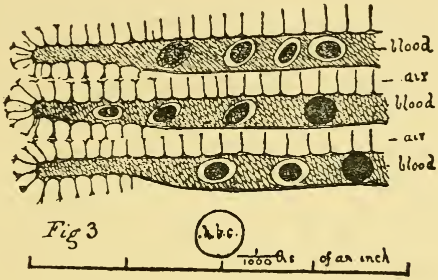


Fig. 3.—Small part of the same, highly magnified, showing the ends of the blood-leaflets, blood-cells inside them, and the hairs which keep them apart to allow free admission to fresh air. *h.b.c.*, Human blood-cell drawn to same scale, and four 1000ths of an inch. Magnified five hundred diameters.

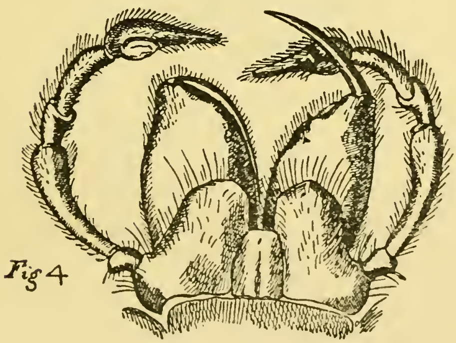


Fig. 4.—External view of mouth of Water Spider, *Agyroneta aquatica*, male, seen from underneath. Showing jaws, fangs, lower lip. and feelers. Magnified ten diameters.

by the pharynx, which acts as a valve (*ph.* Fig. 1 and Fig. 5). This organ is formed by three curved plates—see the cross section Fig. 5,—touching each other. These are controlled by three muscles, all of which are drawn in the same figure, and the upper

one only in the lengthwise section, Fig. 1. It is obvious that, when these muscles contract, the three plates separate, and a passage is opened for the food. It then passes through the stomach, and afterwards into the alimentary canal (in Fig. 1). This figure, as more perfect sections, cut since I drew it, have shown me, is not perfectly accurate in its representation of the stomach and intestine. The stomach is about as intricate in its contours as a walnut in its shell, fitting in amongst the brain and muscles as the walnut's kernel does amongst the surrounding tissues. It has two entrances from the pharynx and one exit into the alimentary canal. Only the exit is shown in the figure. The entrances lie one each side of the exit. The liver (Fig. 1) is a collection of branched tubes, surrounded by glands, which open into the alimentary canal about where (in the figure) the muscles cross it. This structure is not represented.

One of the most conspicuous organs in Fig. 1 is the heart, *ht.* It is hung, so to speak, down the middle of the upper part of the abdomen, by ligaments, four of which are drawn. It is a long, hollow vessel, composed of rings of muscles, and the blood gets into it through little valves in the sides. Their position is correctly shown in the figure, but their shape is not exactly that of the drawing. The blood is pumped through the body by the contraction of these muscles, the wave of motion going from the hinder end forwards. This circulation is worth looking at. Choose a small insect with a transparent skin, and put it alive under the microscope in a cell. You will then see the beating of the heart, pulsations of the returning blood in the head-thorax, and the course of the blood-cells in the legs and in what you may call the "waist"—*i.e.*, the part where the head-thorax joins the abdomen. It is marvellous to see so plainly the generally hidden movements of life. After being forced out of the heart, the blood goes through the spider's waist by the main artery, which at this point is swollen, and has what seems to be a flange-valve. This artery goes over the pharynx, and, in the drawing, it is for the sake of clearness made black and opaque. I rather think it divides into two—an artery for each side of the body—just behind the muscle which lifts the upper plate of the pharynx. Immediately in front of the pharynx these vessels divide again (see

figure). The upper parts continue straight along and supply the jaws, etc.; the lower turn at right angles, and underneath the throat divide once more, this time into six or more vessels each. Two arteries run backward to the abdomen, two forward to the under lip, and four on a side supply the four pairs of legs. In the drawing these last are shown as four tiny circles, being cut at right angles to their length. The blood is not applied to the various organs by means of "capillaries" (very thin tubes), as in higher animals, but issues from the arteries, and touches the parts directly. Neither are there veins to convey it back to the heart. It is obliged, as we may say, to get back the best way it can, in the spaces between the tissues and organs. Insects are said to have neither arteries nor veins, and so in having arteries spiders

Fig 5

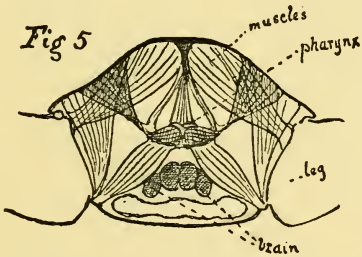


Fig. 5.—Cross section of Head-thorax of Spider, cut through at the place where the dotted line connects the letters *ph* with the organ they indicate in Fig. 1. Magnified ten diameters.

are more highly organised. But before getting back to the heart, the blood, as we all know, requires to be freshened by contact with air, either in the lungs or by some other method. Insects have tubes full of air, called trachea, running throughout the body, and open to the outer air by means of holes in the sides of the body. Here again a spider is considered more highly organised than a true insect. Its blood is freshened by a pair of little organs best called "gills." Some spiders are said to breathe by trachea too. This is not accurate, the so-called trachea being modifications of the ordinary gills. These gills are situated on the under side of the abdomen where it joins the head-thorax, and they open to the outer air by two little transverse slits. They are placed one on

each side of the abdomen, and, after considerable pains, I have arrived at a tolerably complete idea of their structure and function. Fig. 2 gives a lengthwise section of one. The magnifying power is twice as great as in Fig. 1, but its place in Fig. 1 would be—if the section were cut more to one side—exactly where the ovipositor is. In a section cut lengthwise, as in Fig. 2, the gills of a garden-spider appear to consist of about forty very thin pockets or loose leaflets. Only twenty-two are drawn in the figure, because, in the space that ought to contain forty, I could not draw them thin enough. Fig. 3 gives the edges of three of them very highly magnified. A comparison of these two figures will show that the "leaflets" are double—the blood circulates inside them. They are thick enough, and no more, to allow one

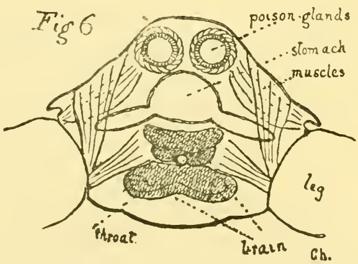


Fig. 6.—Cross section of Head-thorax of Spider, cut through at the place where a line would join the letters *br.* and *p.g.* in Fig. 1. Magnified ten diameters.

layer of blood cells to pass freely. The upper surfaces are seen to be (in Fig. 3) covered with very fine bristles. These bristles keep the leaflets apart, so that air passes between them. Thus, in a spider's gills there are forty layers of blood and forty of air. Manifestly a very large quantity of blood is exposed to the freshening influence of air in a very short time, and although it may not really be more wonderful than many other structures, the singular aptness of this contrivance seems to me to bring before us the wisdom of the Creator in a most striking way. The appearance of Fig. 2 is rather deceptive. It is not so much that there are forty leaflets containing blood, with air between each leaflet, as forty leaflets containing air, between and across which blood flows

from one side to the other. A cross section, although otherwise not showing the gills so well, would show this, because we should then see the *sides* of the leaflets, whereas in the figure given we see the *ends* (at "opening for air"), where leaflet is joined to leaflet. But it does not matter much which way you regard the organ. The blood-cells are nearly as large as those of human blood, the disc *h. b. c.*, in Fig. 3, giving the comparative size of a human blood-cell.

I must now briefly describe the brain and nervous system, and then close this paper. A spider has a distinct brain—which an insect has not: *i.e.*, all the various functions are controlled by a central ganglion, or nerve-junction, instead of by smaller ganglia distributed along the body and forming a "ventral cord," as is the case in insects. This brain is in the lower part of its head-thorax, in its chest, so to say, and contains both nerve fibres and nerve cells (Fig. 1, *br.*, and Figs. 5 and 6). It is made up of smaller ganglia, denoted by the protuberances in the figure. The optic ganglion is shown giving off two optic nerves to the two eyes which come into the section. A spider has eight eyes altogether. Each pair of legs and jaws is controlled by its own ganglion, and in the figure the abdominal ganglion is seen giving off a good thick bundle of nerves. This disappears just as it gets into the abdomen, because I cannot trace it any further, but of course the nerves really go to each separate organ. By the brain we are brought as close as may be to the seat of a spider's will, just as, when we looked at the blood, we saw its seat of life. We cannot "explain" these by calling them "functions of the brain," etc.—that is only the same statement in other words. Truly, in the humble spider there is very much to wonder at and admire.

EXPLANATION OF PLATE III.

Lengthwise section of Garden Spider, *Epeira diadema*, female, showing internal anatomy:—*Ey.*, eyes; *p.p.*, poison-glands; *ht.*, heart; *in.*, intestine, alimentary canal; *l.*, liver; *r.*, rectum; *d.t.*, *d.t.*, *sp.*, discharge-tubes on spinnerets; *o.*, slit or opening for air (see Fig. 2); *op.*, ovipositor; *ph.*, pharynx (see Fig. 5); *br.*, brain (see Figs. 5 and 6); *thr.*, throat (see Fig. 6); *und.*, under-lip; *m.*, mouth; *f.*, fang; *j.*, jaw. Magnified 20 diameters.

The Development of the Tadpole.

By J. W. Gatehouse, F.I.C.

Part 5. Plate IV.

OUR previous observations on the life-history of the tadpole of the frog led us to the point at which the little creature was ready to eat with its mouth ; all previous growth having been due to a gradual change of the undifferentiated cell contents, combined with an absorption of water and food material from the water, in a state of solution through the skin.

The point at which we wish to arrive, is the nature of the food eaten during the after-life history, extending for a period of a little more than two months, the actual dates being from March 29th to June 12th.

Referring back to Fig. 1, Pl. XX., in the last number of the *Journal of Microscopy*, October, 1888, we see that the creature at this period not only had no teeth, but that there appeared to be no rudiments of any such organs, and therefore, that any nourishment taken must have been of the softest and most delicate kind, indeed far more of the nature of a solution as milk, than of a solid as meat or green vegetable matter. It may here be well to mention, that before the larvæ commenced to eat, they were separated into two divisions, one set being placed in a tank with plenty of vegetable matter, consisting of chara, algæ, and duck-weed, with no more animal matter than might be existing naturally on the vegetation, whilst the other portion remained in the tank wherein they had been from the beginning. This tank was kept absolutely free from all vegetable matter during the whole period of the experiments, the animals depending for their sustenance on materials artificially supplied, the water being changed every morning, with as little disturbance to the inmates as possible.

This was effected by a kind of siphon of somewhat peculiar form. The middle part of the instrument consisted of an india-rubber tube, to which glass tubing was attached at either end. Simple tubes answered nicely for a time, but as my pets increased in size and were able to swim vigorously, they would rush to the

orifice of the tube, and by the force of the stream flowing through it were washed over into the exit tank. The tube was now made in the form of a small funnel at the end in the water, and this being covered with muslin offered a large surface for the passage of the liquid, and at the same time prevented the escape of the animals, whilst thus affording a soft cushion for any of them, whose curiosity had led them sufficiently near to be forced against it with a power greater than their own efforts of resistance. There they remained fast prisoners, but quite unhurt till the stoppage of the stream enabled them to swim off again, apparently with great rejoicing. The fresh water was carefully poured in by means of a long funnel, so as not to injure these delicate living morsels, but as they grew stronger a gentle stream was allowed to flow in from the tap.

As before mentioned, the first tadpoles commenced to eat on March 30th, or rather to open and close their mouths as though in the act of eating, and being curious to know the nature of their food, a careful microscopical examination of the water in which they lived was undertaken, with the result that it appeared crowded with minute nucleated corpuscles, varying from the size of pus globules to three or four times that size.

As nothing more substantial could be found in the water, and as the embryos continued to thrive and get more vigorous day by day, the only conclusion which could be arrived at was that they obtained their food from these minute particles floating through the water, and apparently derived from the decomposition of the transparent envelope which had previously surrounded the eggs, but which had now almost disappeared. That this is capable of affording nourishment may be considered certain from its composition being not dissimilar to that of gelatinous substances generally.

On the 1st of April, the little creatures were tempted with portions of fresh liver, but although they soon discovered its presence and smelt around it they did not commence to eat, but seemed to delight in swimming near and in the bloody water exuding from it. Whether on this day they obtained any nourishment or not from this liver, or the exudation from it, I am not able to state; but next morning many of them were evidently sucking and enjoying the juices derived from the meat. It must

be remembered that at this period the mouths of these animals were not furnished with teeth. The diagrams given in this number, Plate IV., show vertical and somewhat oblique sections through the mouths of two of them of March 30th (that is the day on which they commenced to feed), and as in none of the sections cut was there any vestige of even the rudiments of teeth, it must be conceded that these structures would not have been elaborated sufficiently for use within two days.

The mode in which they obtained their food was by applying their mouths as closely as possible to the object, and sucking away at it so as to obtain any liquid or semi-liquid nourishment capable of being extracted. This day, April 2nd, a few animals died, and within the course of the next twenty-four hours many of the living were engaged in devouring them. At the very first we see, therefore, that the tadpole of the frog can live on decomposing animal matter; and that this is more agreeable to them than green living vegetable matter was shown by the relative sizes of the animals thus kept, and of those living in the tank where there was but little animal matter and excess of vegetable in comparison. These latter were not nearly so large or vigorous as the former; indeed they were not so vigorous as those which had been kept in the dark, and fed on animal food.

The only animal food that ever disagreed with these creatures was the spawn or Glochidia of the mussel. Some few years since, I took a quantity of these Glochidia from the gills of a large fresh-water mussel, and placing it in a tank where a number of tadpoles had been thriving, watched the result. No sooner was the spawn at the bottom, than the tadpoles either saw or smelt it out, rushed at it madly, some of them literally wallowing in it, rolling over and over, apparently rejoicing in such a delicate tit-bit. Here, then, one seemed to have procured something in which the little creatures took special delight, but whether they ate too greedily of the tempting morsel and died of repletion, or whether, as is probable, the triangular shell of the Glochidia proving too much for their digestion stuck in the alimentary canal, and thus produced inflammation and death, certain it is that of the whole colony not one was alive next day, and I, taking care to benefit by this experience, have never since attempted to feed tadpoles on mussel Glochidia.

Soft vegetable matters seem to be equally agreeable to their palate with decomposing animal substances, a little bread or biscuit appearing very acceptable, after it had become quite macerated in the water. That they possessed a discerning taste of their own, was seen by the manner in which they fed with avidity from a sweet biscuit, whilst they more or less rejected another containing no sugar; indeed, it is possible to retain these animals in apparent perfect health by feeding them entirely on sweet biscuit, leaving them to obtain their own animal food in the best manner they can. In a tank where many are congregated together, some are certain to die, and in this case the survivors invariably leave *any* food they may be eating to attack the dead bodies of their friends, which are much more juicy and succulent than the majority of the food usually given to them.

From the 10th of April, the animals in the vessel containing much vegetable matter, were found constantly exploring the sides of the glass tank, pressing their noses, or rather the frontal-nasal process which protrudes as a kind of band over and beyond the head, so vigorously against the glass as to remove the algæ growing on it, in lines, so as to produce a number of minute furrows often extending upwards for several inches. In working off this material from the sides of the tank, the general tendency of motion was from below towards the surface, although scarcely ever in a truly vertical direction. For some time, I was of opinion that they were engaged in eating the whole of the material thus ploughed off, as during the process, the mouth could be seen working most energetically, opening and shutting several times per second.

A microscopical examination of this green material showed it to consist of the most heterogeneous mixture, much of it being protococci mixed with minute cells of a linear algæ, as well as with numbers of amœbæ, and crowds of minute animals of all descriptions, both living and dead. A large quantity of this green matter was in a decaying state, and all as soft and succulent as possible, so that when disengaged from the glass the animals could readily suck it into their mouths, no teeth being required to tear it in pieces, as it was already in the most comminuted form possible. A microscopical examination of the fæces of these animals showed

that, although many of the protococci were swallowed, yet it is very problematical whether any nourishments was obtained from them, as numbers were found retaining their green colour, and apparently intact even after passing through the alimentary canal.

What, then, may be asked, is the force of the statement that the tadpole "crops the green herbage of the water-plants," and that its spirally convoluted intestine is well fitted for the digestion of vegetable matter? Do they or do they not crop green vegetable matter? We have seen that where much animal nourishment is not forthcoming, the tadpole will forage for food amongst vegetable matter, and in some instances isolated animals may be seen apparently cropping at morsels of duck-weed. Many times have I examined portions of the duck-weed leaf, thus apparently attacked, to see if any morsels had been eaten, but was never able to observe anything of the kind.

At last, however, a few animals kept by themselves, in a bottle of clean water and only supplied occasionally with food, solved the riddle for me. On the sides of this bottle there gradually appeared numerous white specks having all the appearance of microscopic fungi, which the tadpoles attacked and ate readily. In every instance these white specks proved to consist of colonies of Vorticella attached to the glass by means of their long peduncles, the tadpoles, having nothing better to eat, fell upon and devoured these colonies. Turning, then, my attention again to an animal in the act of apparently cropping green vegetable matter, I found colonies of Vorticella attached to the same frond, so that the conclusion to be drawn from these facts appears to be that the tadpole is a most omnivorous creature, devouring almost everything that comes in its way in the shape of dead or decomposing animal and vegetable matter, and in default of this its natural food is quite willing to content itself with any of the more minute and even miscroscopic creatures it meets in the water. Green food, however, except in the most finely divided state, it cannot eat, and, as I hope to show in a future paper, its teeth, when they appear, are carnivorous rather than herbivorous.

In the sections given herewith, which illustrate the formation of the mouth when first opened, it will be seen that this consists of a wide and elongated sac, armed with prehensile lips. An

interesting feature in Fig. 1, Plate IV., is the section of the heart and its attachment both to the liver and the immature lung by means of the vessels shown, the section fortunately passing through both, and showing not only these, but also the ventricle and auricle of the heart. Tracing back the origin of this organ, we find, by reference to the Plates already given in the April, July, and October numbers, that it has been gradually developing to its present fairly perfect condition. In the April number, Pl. VIII., Fig. 1, immediately above the claspers, *cl.*, but not particularised by any letter, is a sinuous tube. This, although drawn somewhat too wide, gives a fair idea of the condition of the heart on March 9th.

Balfour, in his Embryology, Vol. II., states that the "hearts of *Amphibia*, *Elasmobranchii*, *Cyclostomata*, and Ganoids, are formed as tubular cavities in the splanchnic mesoblast on the ventral side of the throat immediately behind the region of the visceral clefts. The walls of this cavity are formed of two layers, an outer thicker layer, which has at first only the form of a half-tube : being incomplete on the dorsal side ; and an inner lamina formed of delicate flattened cells." The true cavity of the heart is formed within this inner lamina, the outer layer giving rise to the muscular wall and pericardium.

A section of the cavity and pericardium is well seen in Fig. 2, Plate VIII., of the April number; and in Figs. 1, 2, 3, and 4, Plate XIII., of the July number, are indications of the form of the heart in some of its various stages ; Figs. 1 and 2, although very small, especially indicating that at this stage its form is by no means that to which we usually attach the meaning heart-shaped, but rather has it the form of a short spiral, or almost that of the letter S, thus showing an analogy between the hearts of the amphibia and the pisces. Balfour lays some stress on the resemblance to the Dipnoi. In Fig. 3 of the same Plate, the true cordate form begins to be apparent, but as these sections were all cut from the same animal, this is only the form of one particular section, but gradually the simple tube becomes by a constriction separated into a dorsal and ventral portion, the former constituting the auricle, and the latter the ventricle. The whole of the upper portions of both these sections was filled with the brain, indications

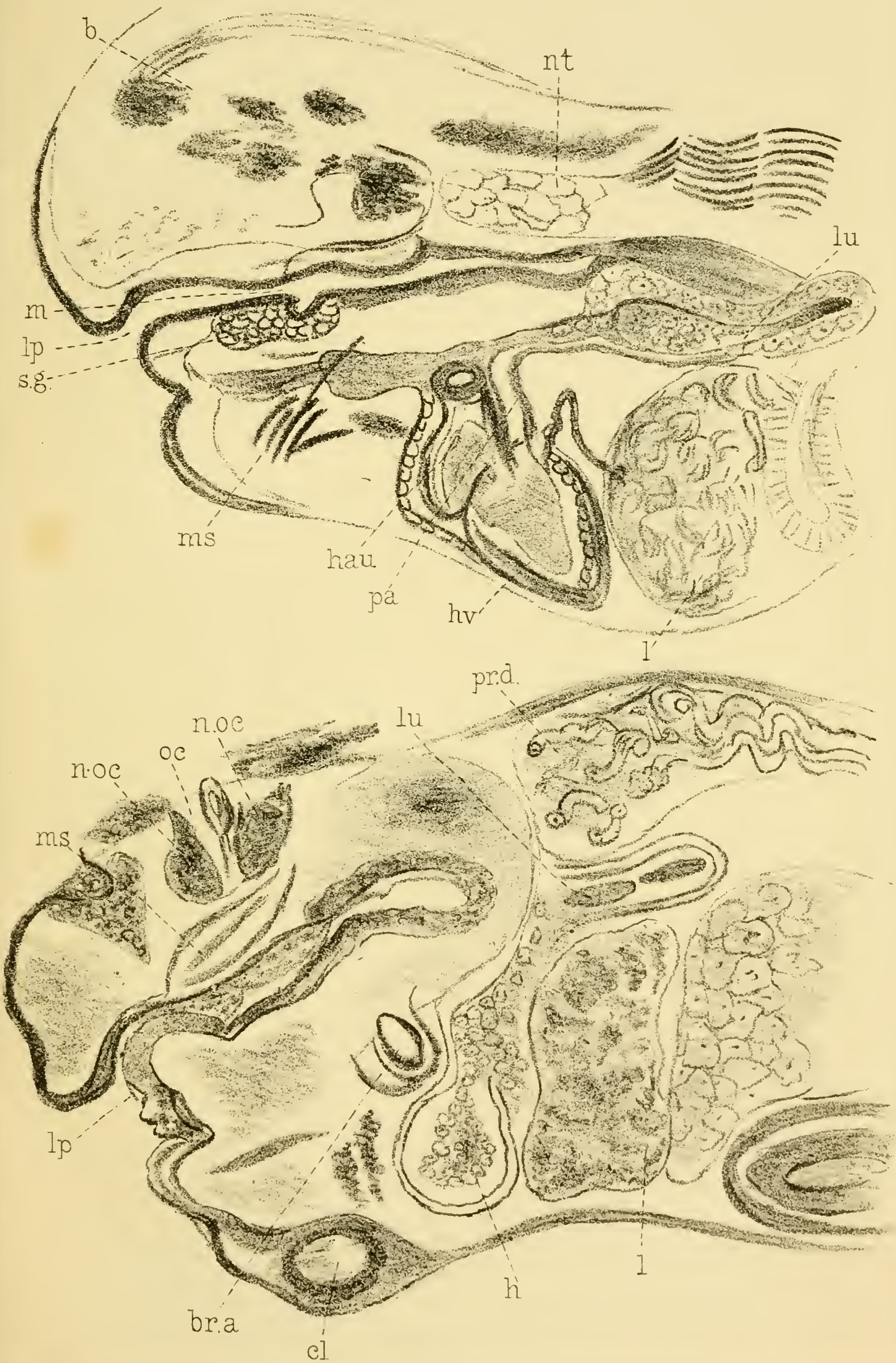
of which only have been given in the diagrams. In Fig. 2 we also find a small portion of the eye, with its nerves, as well as the organ which up to the present has been called the pro-renal ducts, but which may possibly turn out to be also an indication of the ovaries. But more on this point in the future, if our Editor thinks these articles worth continuing.

EXPLANATION OF PLATE IV.

b., brain; *nc.*, notochord; *lu.*, lungs; *lp.*, lips; *l.*, liver; *h.*, heart; *h.v.*, ventricle of heart; *pa.*, pulmonary artery; *prd.*, pro-renal-ducts; *oc.*, optic capsule; *noc.*, nerves of ditto; *ms.*, muscles; *m.*, mouth; *br.a.*, branchial arch; *cl.*, claspers; *s.g.*, salivary glands × 50.

Collecting Diatoms.

In an interesting article in the *Bulletin of the Torrey Botanical Club*, Dr. C. Henry Kain discusses the "Diatoms of Atlantic City and Vicinity." Speaking of the bright brown patches of diatoms frequently seen covering the surface of the mud, he recommends that they be collected in the following manner:—Half fill a bottle with water. Touch one of these brown patches lightly with the tip of the finger, and the diatoms will adhere; then place the finger over the mouth of the bottle, and shake. The diatoms are, of course, washed off, and remain. By repeating this process, again and again, the water finally becomes quite brown. By the time the collector reaches home, the diatoms will have settled to the bottom, and the water may be poured off, and the diatoms cleaned. It is worth while to examine under the collecting lens every prominent patch of brown mud, for many pure gatherings of quite different species may often be collected within a few feet of each other.



Development of the Tadpole

The Mammalia: Extinct Species and Surviving Forms.

By Mrs. Alice Bodington.

Plates V., VI., VII.

THE lovers of Zoology find their favourite study become ever increasingly fascinating, as the discoveries of modern palæontology more and more triumphantly vindicate the theory of evolution. Although that theory received its greatest impetus in England and on the Continent from the works of Darwin, yet it is evident that the great master himself had only grasped one form of the law governing evolution. He sought, at least in his earlier works, to account for all changes in animals and plants by natural selection; whereas we now see that the infinite, delicate variations in the world of organic beings are owing to the intense irritability and susceptibility to molecular changes of protoplasm, and the consequent action of the environment upon it. Natural selection evoked some unknown force vaguely of the nature of will. The action of the environment upon protoplasm requires nothing but ordinary and well-known phenomena of organic chemistry.

In 1861, Darwin thought the "direct action of the conditions of life cannot but have played an extremely small part in producing all the numerous and beautiful variations in every living creature." But in one of his later letters we see how much he had seen reason to change his views on this point, for he says:—"In my opinion, the greatest error I have committed has been in not allowing sufficient weight to the direct action of the environment, independently of natural selection." Natural selection is by no means excluded, but plays only a subordinate part in the great drama of development.

The zoologist can now trace pedigrees to which the longest human pedigree is but as the flash of a second; a pedigree showing the most delicate and gradual changes: a cusp of a tooth disappearing here, a joint becoming anchylosed there, yet by slight, constant variations affecting the most startling changes of structure. He can trace the camel, the horse, the dog, the cat, to

their primitive, or rather to their most simple forms. For the truly primitive forms from which the higher animals are descended are as yet undiscovered—possibly, buried for ever beneath the ocean, but ever sought with unwearied skill and patience.

The labours of the embryologist and the comparative anatomist enable us, through the "scientific imagination," more or less imperfectly, to reconstruct these ancient forms. But the oldest mammals known, though almost reptilian in development in comparison with the mammalia of the present day, are yet highly differentiated, and must have had long lines of ancestors.

The problem to which I chiefly desire to attract attention in this article is that of the extinction of species. It is usually assumed that some catastrophe must have led to the destruction of any given species. The glacial period accounts conveniently for the disappearance of many forms. It is gravely stated that the oceans are now not large enough for all the whales that formerly flourished; and a general drying up of swamps is supposed to account for the disappearance of the earlier pachyderms. But we have every reason to doubt a theory which requires constant catastrophes to make it tenable.

Another theory, which has an undoubted mingling of fact to support it, is that the lower animals necessarily die out in the struggle for existence before the higher ones. But, as I hope to be able to show, though the lower orders of mammals tend to disappear before the higher ones, yet species, and even orders, die out where *there has been no competition with higher forms.*

It will make the difficulties of the question to be solved appear more clearly if we go through the main orders of mammals, and see how few species, comparatively speaking, survive, and how mysterious are the laws governing their appearance and disappearance. We will consider the Marsupials first. In this order, as is well known, no placenta is developed, and the mother animal transfers the embryo in a very immature condition to an external pouch. Until lately, it was thought that the Marsupials made their earliest appearance in Europe, and it was plausibly urged that they had necessarily died out before the higher placental forms. In the Miocene period, they had become extinct, both in Europe and in North America.

This theory is highly satisfactory till we examine into the history of the Marsupials in their own island-continent, Australia. Australia was cut off from the rest of the world before the Cretaceous period and before the placental mammals had had time to arrive on its soil. Here the Marsupials were the masters of all they surveyed. What happened? They flourished and developed in all possible ways. They became differentiated into vegetable-feeders, into insect- and root-eaters, into formidable carnivorous animals; they lived in trees, flew after the fashion of bats, burrowed in holes; and, in short, mimicked most of the great animal orders in other parts of the world. Some attained a gigantic size, and must have been as much as sixteen feet high, the largest existing kangaroo measuring about five feet. The living genus, *Macropus* (the kangaroo), was represented in the Post-Tertiary deposits by species in all essential respects agreeing with the recent forms, but of immense size, one species being as large as the rhinoceros. *Diprotodon* had a skull more than a yard in length, and was about sixteen feet in height. It was, says Owen, a giant kangaroo, but without the power of leaping. *Thylacoleo* was named by Owen the Marsupial Lion, which animal it rivalled in size. The dentition was not the same as that of the carnivorous marsupials of the present day, but was of so powerful and formidable a character as irresistibly to suggest the habits of a beast of prey.

The Wombats are represented by fossil species, partly corresponding with them in size and partly far exceeding them. *Nototherium*, for instance, far exceeded the living species in size, and had the most hideous skull imaginable—very nearly as broad as it was long. The living Marsupials of Australia are evidently, therefore, but diminished and scattered survivals of the Marsupials of the past.* All these fossil Marsupials, too, belong to the most recent geological period. On the Darling Downs, Leichhard collected bones which were so little like fossils that he expressed a hope that he would find living specimens of the same animals further in the interior of the Continent. Here, in Australia, the Marsupials had no rivals. There was no Glacial

* Schmidt.

epoch which has so conveniently killed off all sorts of animals in Europe. Things have gone on in Australia since Post-Tertiary times much as they are going on now. Man himself has probably only recently become a denizen of this "fifth quarter" of the globe. He appears in the rudest and most primitive state, and was unable to kill off even the diminished kangaroos of the present day. Therefore, it seems safe to say that there is a *law governing the duration of species.* As a man may die by accident or disease after a longer or shorter life, yet must at last die of old age, so it seems to be with species and even orders of animals. They may be *prematurely* destroyed by glacial epochs, or drying up of marshes, or inundations of the sea, but if they are exposed to no possibility of perishing by external accidents, *the species dies out of old age.*

The Liberal-Conservative animals, if I may be allowed to borrow a term from politics, seem to have the best chance of comparatively long duration : those which do not change too quickly or too slowly. The frogs have outlived the enterprising *Deinosaurs* by long ages, and the elephant has persisted longer than the much bigger and more formidably tusked mammoth, *Deinoceras*, (whose reptilian brain could suggest no method of making a mark in the world except by growing six horns on the top of his nose), was doomed to a particularly speedy extinction.

Having shortly examined the Marsupials of Australia and seen how they died out or diminished, notwithstanding every advantage in the struggle for existence, we will next examine the Proboscideans, of whom the only living representatives are the two closely-allied species of modern elephants. No animals apparently could be more fitted to survive in the struggle for existence. They were mostly of gigantic size, with a formidableness of tusk and a thickness of skin which made them almost invulnerable. Their huge, compressed molars, growing from persistent pulps, served them throughout the longest life. Their food, consisting of leaves and vegetables and branches of trees, was unlikely to fail them. Yet we have but the meagre survival of two species in the present day. The Glacial period appears hazily to account for the extinction of the Mammoth, though he seems to have lived pretty comfortably through it, and to

have survived to sit as artist's model to primitive man. But allowing that the Mammoth died—say, of regret that the Glacial period was passing away—what killed the Mastodon and the Deinotherium? The Mastodon survived the Post-Pliocene times; the Deinotherium grew tired of a naughty world in one short Tertiary period, the Miocene. Yet, apparently, it might have found swamps to its heart's content down to the present day.

Three species of extinct elephants appeared in the Upper Miocene of India alone, where certainly there were no climatic conditions to interfere with their continuance. They ranged over Britain, Europe, Asia, and North America. They are found of all sizes, some being no bigger than goats or donkeys. The pigmy elephant of Malta was four feet and a-half in height, and the *Elephas Falconeri* of Busk was still smaller, its average height not exceeding two and a-half to three feet. But they have passed away just like their larger brothers. One is often tempted to think that unwieldy size is one of the factors in the extinction of species; but evidently the tiny elephant of Busk did not perish for that reason.

From the Proboscidea, we come to the most primitive of all surviving Ungulata, the Camel, of which there are but two closely-allied living species, the two-humped Bactrian camel and the dromedary, a native of the deserts of Arabia. The true camels appear with startling suddenness in the Old World. They are found developed precisely as they are now in the Siwalik Hills of India. But the genus Camelidæ (camels and llamas) appears with an immense wealth of species in North America. *Procamelus* only differed from the existing camels in having four præmolars on each side of the jaw instead of three. The family history of the *Camelidæ* is as perfect and almost as interesting as that of the horse. Their earliest-known ancestor seems to have been the "Miocene *Poebrotherium*, in which the bones of the foot had not coalesced, and the mouth was furnished with a complete set of incisor teeth, through *Protolabus*, whose incisors are present in full number, but fall out readily; *Procamelus*, with incisors like those of our present camel; and metatarsals (bones of foot), which have coalesced and become the 'canon-bone'; and finally, *Pliauchenia* and *Auchenia*, leading up to the present llamas. A

more and more continuous delay in the formation of the teeth is observed; the teeth eventually *no longer cut the gum*, and finally disappear completely—a process repeated in many other lines of descent," as in the fœtal teeth of many rodents, ungulates, and whales, and called by Professor Cope "the Law of Retardation."

Four families of *Camelidæ* survive in South America, but in North America—to all appearance, the original home of the genus—they have become totally extinct. A llama larger than any existing camel survived in North America to Post-Pliocene times. How shall we account for the disappearance of these swarms of the camel tribe from North America, where all conditions of existence seemed favourable to them, and how shall we explain their sudden appearance in Asia and continued survival in the Old World? Possibly, as the camel is now no longer to be found in a wild state, this archaic form has only been preserved through its serviceableness to man.

It may be interesting to those who are not professed zoologists to explain that the great distinction between the camels and all other living ruminants is that they have six teeth in addition to the molars in the upper jaw, whereas other ruminants have no incisors or canines whatever in the upper jaw. The teeth in the lower jaw are also less highly specialised than those of oxen or sheep. The feet have two toes encased in small, imperfect hoofs, and the sole of the foot is broad and horny, but the skeleton of the foot is that of a true Ruminant.

The genus *Equus* (horse, zebra, and ass) has had an equally curious history of long and slow development, of a palmy time, when it roamed—with numerous species and countless herds—over the plains of North America; of an extinction apparently as sudden as its rise was slow, an extinction complete and unaccountable. For the American horse survived almost to historical times, and the genus, when re-introduced into America by the Spaniards, throve and multiplied in a wild state, in a manner which showed that continent was still eminently suited to it, both as regarded climate and mode of life.

The pedigree of the horse is one of peculiar interest, owing to the high state of specialisation reached by this animal, and the completeness with which every step in its progress has been

followed. In the early days of Darwinism, evolutionists were scornfully told to produce a five-toed ancestor of the horse. Accustomed only to the narrow range of historical time, the opponents of evolution thought that because animals—such as the horse, the bull, and the cat—were the same in old pictured inscriptions as they are now, that, therefore, they must have been originally created just as we see them.

We will briefly give the pedigree of the horse. As it is the most perfect and curious of animal pedigrees, so it is also the most widely known. In the Lower Eocene of New Mexico are found the remains of *Eohippus*, an animal about the size of a fox, which had the full number of teeth (44) and a *rudimentary thumb*, besides four toes on its fore feet. The hind feet had three toes, and all the digits terminated in hoofs.

In beds rather higher than those containing *Eohippus*, *Orohippus* is found. It was of about the same size as *Eohippus*, and possessed four toes on the fore feet and three toes on the hind feet; but the *third digit is the largest*, and the rudimentary thumb has disappeared. It has still 44 teeth, but a long interval separates the premolars from the canines, a peculiarity which still more strongly characterises the modern horse.

In the Lower Miocene, *Mesohippus* appears, an animal about as large as a sheep, but with longer legs. The fore feet are now three-toed, and a "splint-bone" only remains to represent the little finger. *Anchitherium*, of the European Miocene, represents one step further in advance. There were three toes which reached the ground on each foot, but the middle one was the largest, and even the splint-bone representing the fifth toe had disappeared.

In late Miocene and early Pliocene times, a much more distinctly horse-like form makes its appearance, though the anatomical differences between *Hipparion* and its predecessor are not great. The central toe (third digit) is now the only toe which touches the ground, whilst the second and fourth digits, though visible externally and furnished with small hoofs, are so much reduced in size as to take no part in supporting the weight of the body.

Finally appears the true horse, in which the useless second and fourth digits of *Hipparion* are reduced to "splint-bones," concealed beneath the skin.

In America, two forms of perfect Solipedes were evolved: *Pliohippus*—which, like *Hipparion*, was about the size of a donkey—and our modern horse. As the toes can be traced step by step in their modifications, so we can also follow the specialisation of the teeth. This, though very curious, has not kept pace with the extraordinary modification of the toes. The modern horse still possesses 40 teeth, but the first pre-molar, which was a good "working tooth" in Eocene and Miocene species, is in all modern horses rudimentary, functionless, and early lost. The canines also have greatly diminished in size and are rarely present in the mare, so that practically a very large number of adult horses have eight teeth less than their predecessors.

No fossil Solipede was larger than the horse of modern times. In this respect, the horse forms rather an exception among the land Mammalia, showing that it is now probably at the highest point of perfection of which the species is capable. The anthromorphic apes and the genus Equus are amongst the few land Mammalia which can show no extinct members of their order excelling them in size. Man belongs to an order which has not yet degenerated. What his "expectations of life," as a species, may be, can be guessed from the fate of other species. Historically speaking, his endurance may be very long; geologically speaking, it will probably be brief.

The Perissodactyls (odd-toed, hoofed animals) survive in a more fragmentary form than perhaps any other sub-order of Mammals. Of the seven principal families of Perissodactyls, three alone survive, and one only has not degenerated in size (*Equus*.) Of the genus Tapiridæ, one family alone—the tapirs—survive. They were represented by an enormous amount of forms, ranging from the Eocene downwards, and varying from the size of a hare to that of a rhinoceros. The rhinoceros is a heavy animal of conservative type, which has managed to exist from Miocene times, and is represented, even in the Eocene, by allied genera, differing chiefly from the existing rhinoceros in possessing no nasal-horns. The most highly specialised form of rhinoceros (*R. Tichorrinus*, the celebrated woolly rhinoceros), which had the nasal septum completely ossified to support the horns, died out sooner than the less specialised forms. As is well known, it was

an inhabitant of Britain, and lived to be the contemporary of man. Quite recently, one of these enormous animals has been suddenly revealed in his "habit as he lived." Part of a river cliff, in Siberia, was broken away by a thaw, and there stood a perfect woolly rhinoceros, perfect in hide and hair, as in life. An admirable illustration of the animal appeared in "St. Nicholas" for March of last year. Its life, as a species, was remarkably short. It is "essentially a Post-glacial Mammal, and is mainly found in quaternary cave-deposits and river gravels" (Nicholson).

Our modern rhinoceroses are therefore amongst the most ancient "survivals" among Mammals, and have diminished very little in size, though wofully in number of species, there being only one living genus. The extinct families of Perissodactyls were mostly clumsy animals of low specialisation and undeveloped brain. In Coryphodon of the Eocene, "casts of the brain-case indicate that the cerebellum was large, the cerebral hemispheres much reduced in size, and the olfactory lobes large, and entirely in advance of the hemispheres," and the "dentition was complete,"—an infallible sign of low development. Each of the five horny toes, also, was functionally complete. The extinct *Brontotheridæ*, from the Miocene of North America, had brains as low in type as that of Coryphodon. Their feet and teeth were rather more specialised, and they had two large horn-cores upon the maxillary bones.

The *Palæotheridæ* show affinities with both the tapir and the horse, and probably included amongst their number the ancestors of these latter animals. Macrauchenia had affinities with both the camel and the horse. In short, in Eocene and Miocene times, whilst orders were more or less clearly marked out, species were still in wild confusion, and everything appears to have affinities with everything else.

Amongst the Artiodactyls, or pair-hoofed Ungulates, we have a most curious surviving example in the hippopotamus, of the primary type from the Eocene. The "Eocene animals, with tuberculate teeth, and likewise the Early Tertiary ancestors of the ruminants, with crescentic teeth, had to dwell principally in waters and marshy ground. Their descendants, for the most part, adapted themselves gradually to life on dry ground, and this is

connected with the advantageous reduction of the toes. The hippopotamus family has taken an opposite course; from being an animal that liked the marshy soil of primæval forests, it has become almost an aquatic creature (suckling its young in the water), and accordingly has preserved the completeness of hand and foot, the four toes almost fully developed. As regards dentition, also, the hippopotamus shows signs of being, geologically, very old. The skull of the unwieldy creature reminds one of a clumsily-formed box. The breadth and height of the muzzle are produced by the enormous development of the middle incisors and canines, all of which teeth are furnished with roots that are not closed, but open wide apart." *

The great antiquity of the hippopotamus is also brought home to us by the fact that species have been found in Madagascar, where their remains were embedded in marshy deposits, together with those of the colossal bird, *Æpyornis*. Now, granting that Africa and Madagascar were, at one time, connected by land, their separation must have taken place early in the Tertiary, and accordingly the stability of the genus hippopotamus is also proved from a geological point of view.

Nature has certainly improved in her conceptions of animal beauty as time has gone on. The ancient reptiles rivalled one another in hideousness of form, and the more ancient types of mammals, which have survived to our own day, are grotesquely ugly; such, for instance, as the elephant, the hippopotamus, the rhinoceros, and even that useful friend of man, the pig. Most of their early contemporaries seem to have been still uglier, but at least they did not live to distress the artistic eye of man with their uncouth forms. And man himself has much improved upon the ancient Miocene form, which survives, almost unchanged, in the modern anthropomorphic apes. Though the law of natural selection plays a less important part in the development of species than we once thought it did, at least we can give to its action the credit of having made improvements in beauty.

The pedigree of the other family of tuberculate-toothed, hoofed animals—the *Suidæ*, or hogs and peccaries—is a very ancient one. It can be traced back to the Eocene, when the

* Cope.

genera, *Paleochœrus* and *Chœrotherium*, had already the dentition of the pig species, but still had the full number of functional toes. The hogs and peccaries, though so nearly allied, have two distinct lines of pedigree. America possessed a line of pig-shaped animals, which may be traced up from the Eocene *Eohyus* up to the modern peccary. Immense numbers of collateral branches were thrown out, some attaining the size of a hippopotamus. In speaking of *Eohyus* of the Lower Eocene of North America, Professor Marsh observes :—" In every vigorous primitive type which was destined to survive many geological changes, there seems to have been a tendency to throw off lateral branches, which became highly specialised and soon died out, because they were unable to adapt themselves to new conditions. The narrow path of the persistent Suilline type, throughout the whole Tertiary, is strewn with the remains of such ambitious offshoots; while the typical pig, with an obstinacy never lost, has held on in spite of catastrophes and evolution, and still lives at the present day. In the Lower Eocene, we have the genus *Parahyus*, apparently one of these short-lived specialised branches. It attained a much greater size than the true lineal forms, and the number of its teeth was much reduced. In the Middle Eocene we have on, or near, the true line, *Helohyus*. All these early Suillines, with the possible exception of *Parahyus*, appear to have had at least four toes, all of useable size. In the Lower Miocene, we find the genus *Perchœrus*, seemingly a true Suilline, and with it remains of a larger form, *Elotherium*, are abundant. *Elotherium* lived both in America and Europe. It affords another example of the Suilline offshoots already mentioned. Some of the species were nearly as large as a rhinoceros, and in all there were but *two serviceable toes*, the outer digits seen in the modern pig being represented only by small rudiments concealed beneath the skin."

Enormous numbers of transitional forms existed also in the three Tertiary periods, presenting characteristics both of the pigs and the ruminants. Of these, one of the most curious was the family of the *Anoplotheridæ*. *Anoplotherium* of the Eocene was about the size and shape of an ass. It possessed a long-pointed tail. Its molar teeth resemble, in some respects, those of the rhinoceros, and its dentition is peculiarly primitive, as it pos-

sessed 44 teeth, the crowns of which were nearly on the same level. The feet, on the contrary, are very highly specialised and deer-like, there being but two toes. The Miocene genus, *Chalicotherium*, which occurred in North America, China, India, and Europe, was of an allied family, and comprised species as large as the existing rhinoceros. None of these animals survived the Miocene period. Another family, which was too "mixed up" in type to have a chance of survival, was that of the *Oreodontidæ*, of the Miocene and Pliocene of North America. The family is termed by Leidy "ruminating hogs." Their canines were large and pig-like, their pre-molars were of ruminant type, and the molars had the doubly crescentic form of the typical Selenodont Artiodactyls, or true Ruminants. Their feet had four toes, and their number of teeth was complete, in which, of course, they differed both from hogs and sheep. Not content with these confused efforts at becoming sheep and hogs at the same time, they developed tear-pits like the typical deer. Exhausted with these incongruous efforts, the *Oriodontidæ* disappeared for ever in the Pliocene.

We have wandered a long way from the true hogs, of which I will only say that though they have persisted in type in a wonderful manner, they have as usual decreased both in size and in number of surviving species. The "Erymanthian Wild Boar," found fossil in Attica, was larger than any existing hog, and an immense wild boar existed on the Siwalik Hills of India. The common hog (*Sus scrofa*) once wandered wild over the greater part of temperate Europe and Asia, and was an early inhabitant of Britain. Its remains are found in the Post-Pliocene forest-bed of Norfolk, but it was completely exterminated as a wild species in that region many centuries ago.

The majority of living Ruminants are divided into the large families of the Oxen, Sheep, Antelopes, and Deer. The typical Ruminants are highly specialised, both in their limbs and their dentition. There are no incisor teeth in the upper jaw, their place being taken by a callous pad of hardened gum. There are also no upper canine teeth, and the only teeth in the upper jaw are six molars on each side. In the front of the lower jaw is a continuous and uninterrupted series of eight teeth; then there is

a vacant space, followed by six grinders. The dental formula, then, for a typical ruminant animal is

$$i.\ \frac{0-0}{3-3},\ c.\ \frac{0-0}{1-1},\ pm.\ \frac{3-3}{3-3},\ m.\ \frac{3-3}{3-3} = 32$$

The departures from this typical form occur in the camels, the Chevrotains (*Tragulus*), and in some of the deer. The Chevrotains are survivals of the Miocene family of *Tragulidæ.* They are characterised by a total absence of horns, by the possession of canine teeth, and by other peculiarities of structure which make them an intermediate form between the hog and the deer. They are the smallest and least specialised Ruminants existing. The true Ruminants, though animals of a peculiarly modern type, have yet seen their palmiest days. The Post-Pliocene was the age when the true stags attained their largest size and greatest abundance. The Irish Elk (*Cervus Megaceros*) was remarkable for its great size and the enormous dimensions of its spreading antlers, which attained an expanse of as much as ten feet from tip to tip. It appears and disappears in the Post-Tertiary period. Another remarkable type of stag, with antlers of very complicated form, is found in the Norfolk forest-bed.

Of the family of the Cavicornia (oxen, sheep, goats, and antelopes) the sheep appear to be the most recent. No remains of *Ovidæ* are found in any deposits older than the Post-Miocene. Nor have they diminished in size, though the beautiful Big Horn of the Rocky Mountains seems threatened with extinction by man, and the Musk-Ox (*Ovibos Moschatus*) has found its last refuge in Arctic America. Formerly, this curious ox-like sheep roamed throughout the Quaternary deposits of Europe and Asia. Doubtless, though the sheep have not yet diminished, the hand of fate visibly points in the same direction for them as for other species.

The oxen are much older than the sheep, extinct species of the living genus *Bos* being found in the Upper Miocene of India, together with the extinct genera, *Hemibos* and *Amphibos.* The palmy days of the oxen were the same as those of the stag, in the Post-Pliocene period. And probably it would not be too much to say that if the ox had not been peculiarly useful to man, the genus would now have been extinct in Europe—would have

disappeared as the American bison is now disappearing. The wild bull survived to a late historical period, and was one of the most dreaded *feræ naturæ* of Scotland.

> "Mightiest of all the beasts of chace
> That roam in woody Caledon,
> Crashing the forest in his race,
> The mountain bull comes thundering on,"

sings Sir Walter Scott.

It is doubtful whether the wild cattle preserved in Chillingham Park are degenerate descendants of the mighty Urus (*Bos primigenius*), or only the offspring of a domestic breed run wild. Their comparatively small size and evident tendency to vary in colour seem to point out the latter as the more probable view. A Welsh breed, white with red ears, similar to the Chillingham cattle, existed in Wales in the 10th century. Welsh chroniclers relate that the anger of King John was once appeased by a gift of 1,400 of these white cattle, showing that the latter were sufficiently under control to be collected and conveyed from one part of the country to the other; in short, that they existed at that time as a domesticated breed.

The gigantic *Urus* is then, in all probability, extinct. It "appears to have been domesticated amongst the Swiss lake-dwellers, abounding then and down to historic times in the forests of Europe. Cæsar describes it as existing in his time in the Hercynian forest, in size almost as large as an elephant, but in form and colour like a bull. Its immense size may be gathered from the fact that a skull in the British Museum, found near Athole, in Perthshire, measures one yard in length, whilst the span of the horn-cores is three feet six inches."

Two other species of cattle, *Bos longifrons* and *Bos frontosus*, are now extinct, but were probably the progenitors of many races of domestic cattle in Europe.

The Aurochs, or Lithuanian bison, can hardly be considered as a fossil form, as it is preserved with great care in the forests, belonging to the Emperor of Russia, in Lithuania. But the remains of this large ox are found abundantly in various prehistoric deposits, and we cannot doubt that the Aurochs owes its present existence, as a race, to the care of man. *Bos primigenius*

was a contemporary of the Mammoth, woolly rhinoceros, cave-lion, cave-bear, Irish elk, and sabre-toothed tiger, all of which exceeded the corresponding forms at present existing in size, and all of which have completely passed away.

We will now enquire how the Carnivora have fared in the struggle for life. The least specialised family of Carnivores is that of the bears, which, however, holds its own in the world, quite as well as the more highly specialised forms, and, in fact, has something of the dogged persistence in not improving too fast which characterises the pig. In walking, the bear applies the whole sole of the foot to the ground, thereby keeping close to the primitive type of foot. The teeth, also, are only partially adapted to a carnivorous diet, for though the incisors and canines have the ordinary carnivorous form, the "carnassial" tooth, so characteristic of the flesh-eaters, has a tuberculate crown, instead of a sharp, cutting edge. The bears proper make their appearance at a comparatively late date; the oldest-known types belonging to the genus *Hyænarctos* of the Miocene. But forms, leading up to the bears, can be traced much further back, till at last we come to the bear-dog, *Amphicyon*, from which can be traced the descent of both bears and dogs (Oscar Schmidt, Heilprinn).

The bear-dog, *Hyænarctos*, had a more specialised dentition than the bears, and died out early. The true bears have rather increased than diminished in number of species, but in size, no living bear, not even the dreaded "grizzly," could compete with the gigantic cave-bear (*Ursus Spelæus*), of the Post-Pliocene period. The "grizzly," itself, is probably identical with "*Ursus ferox*," of the Tertiary. No fossil remains of bears are to be found in America, so that we may safely conclude the *Ursidæ* to be of European origin.

The most powerful and highly specialised Carnivores are, of course, the cats (*Felidæ*), in which the teeth are reduced to thirty. The canines are formidably developed, and all the molars and pre-molars are trenchant, except the last molar in the upper jaw. The claws are withdrawn within sheaths when not in use, and so kept always sharp. The cats have a world-wide distribution, and are the most formidable of modern flesh-eating animals. But they have diminished in size since Post-Pliocene times. The

cave-lion, which hunted its prey as far north as Yorkshire and the frontier of Poland, resembled *Felis leo* in all but its superior size.

Our chief interest, at present, however, centres in a member of the *Felidæ*, which was more highly specialised than any existing form. This most terrible of all the cats was *Machairodus*, the celebrated sabre-toothed tiger. Its teeth were reduced to twenty-six. The canines were extraordinarily developed, trenchant and sabre-shaped. There is a theory that *Machairodus* died out because it finally could not shut its mouth. This theory may serve as well, or as ill, as any other, which, with our present knowledge, attempts to account for the dying out of species. Its range was very wide, for the remains of the sabre-toothed tiger are found in Britain, in Europe, in India, and in North and South America. It appears first in the Miocene, and disappears in the Post-Pliocene.

An equally terrible animal, *Hyænodon horridus*, is found in the Eocene and Miocene of Europe. It had the complete number of teeth, 44, but these were all of the carnassial type, intended for tearing flesh, and it had no tubercular molars. There were many families of this genus, but though they were apparently perfectly capable of shutting their mouths, they disappeared, as afterwards did the sabre-toothed tiger.

The family pedigree of the cats is a long and a most satisfactory and interesting one. In Oscar Schmidt's "Mammalia," will be found the account of the descent of the *Felidæ*, through the *Viverræ* or weasels, from the Viverrine dog, *Cynodictis*, which possessed the dental formula of the dog.

$$i.\ \frac{3}{3},\ c.\ \frac{1}{1},\ p.m.\ \frac{4}{4},\ m.\ \frac{3}{3}$$

The line can be traced, literally, tooth by tooth, from *Cynodictis* of the Eocene, through *Prœlurus* and *Pseudœlurus*, to the genus *Felis*, and even further on to *Machairodus*. These transitional forms have been mostly traced in France, by Filhol, from the Eocene deposits of South Western France, to the lower Miocene deposits of Saint Gérard le Puy on the Allier, and the upper Eocene Phosphorites of Quercy. The pedigree given by Oscar Schmidt of the Felidæ and Viverræ will be found interesting :—

Viverrine Dog (*Cynodictis*)
|
Viverræ
|
Plesictis
|
Stenoplesictis
|

Prælurus	Palæoprionodon
Pseudælurus	Weasels
Cats	
Sabre-toothed tiger	

It will be seen that two ancient forms, with the dentition of dogs, were the ancestors of the dogs, bears, cats, and weasels; *Cynodictis* of the more highly specialised Carnivores, and *Amphicyon* of the wolves and bears.

The *Cetacea* (whales and dolphins, etc.) are, as Nicholson says, "not particularly interesting from a palæontological point of view," insomuch that the remains of comparatively few extinct species are to be found. Their fullest development occurred in the Miocene period, when there were both large and small whalebone whales (the small from two to ten feet long), dolphins, and the two entirely extinct genera, *Zeuglodon* and *Squalodon*. They have rather increased than diminished in size in modern times; the modern whale sometimes reaching a length of from 90 to 100 feet. But from the point of view of evolutionists, the Cetacea present some extraordinary and (so far) insoluble problems. Certain points in the Cetacea bring them close to the primitive hoofed animals—for instance, the "complex stomach, the simple liver, the respiratory organs, but mainly the reproductive organs." That the whale is in every respect, but in that of outward adaptation to an aquatic life, a true Mammal, everyone knows. That it once possessed four legs is also evident from the rudimentary pelvic bones, and last remnant of a thigh bone in the modern

whale; and that it once possessed the ordinary Mammalian dentition is shown by the fœtal teeth of the unborn whale, which are absorbed before birth. Yet, this most highly specialised animal, which, upon any theory of evolution, must have taken thousands upon thousands of years for its profound modifications of form, is yet found in the oldest Tertiary beds; possibly, in rocks of the upper Jurassic age (*Palæocetus Sedgwickii*). The oldest Cetaceans, the Zeuglodons, have a much less highly specialised dentition than the modern whales. They have strong molar teeth, with serrated crowns, sometimes ten in number, and implanted in the jaw by two roots, incisors, and a deciduous dentition. But the profound modifications of the hinder portions of the skeleton remain the same. The whales are also peculiarly refractory to the special-creation hypothesis, for it is impossible to imagine an animal created with teeth in the fœtal state only and a rudimentary pelvis and femur.

The Sirenians, which have many points of affinity with the Cetaceans, are rapidly dying out. The highly-modified form, *Rhytina*, possessing no true teeth, was exterminated about the middle of the eighteenth century. All the Sirenia possess a rudimentary pelvis, but it has become detached from the vertebral column, and the rudimentary thigh-bone has wholly disappeared. *Halitherium*, a Sirenian of the Miocene, still possessed a rudimentary femur. The Sirenians appear, like the whales, in the Eocene period. Unlike the Ungulata and the Carnivora, which can be traced back step by step to more generalised forms, the Sirenia and Cetacea appear suddenly before us at the earliest Tertiary period, with their profound modifications of form. The comparative anatomist is almost forced to the conclusion that the rocks of some long geological age are somewhere concealed beneath the sea—perhaps lost to our eyes for ever, only to be descried by the scientific imagination.

Not only the Cetacea and Sirenia, but other highly specialised forms appear suddenly before us in the Eocene. The bats, the most deeply modified of all the Insectivora (and not only the sub-order bats, but a form *closely similar to the existing European bat)*, appear in the Eocene of Europe. The Edentata (sloths, armadillos, etc.) have been found no further back than the

Miocene Tertiary of Europe and North America. But they appear at once with their strange peculiarities of dentition and uncomfortable method of progression. In two genera of the Edentata there are no teeth; in the remaining members of the order the teeth have no true enamel, are destitute of complete roots, and the incisors are completely wanting in all but the armadillos. The sloths and many other Edentates walk upon the outside edges of their fore and hind limbs, with the claws of their feet bent inwards. The sloths probably find this arrangement of limb highly conducive to comfort, as they live hanging upside down from branches of trees, and their claws form natural hooks. The oldest representative of the Edentata, the gigantic *Macrotherium* of the Miocene Tertiary of France, walked in precisely the same way. The toes were furnished with immense claws, which were bent inwards upon the palms of the hands and the soles of the feet, owing to the bending of the first phalanges (finger and toe-bones) upon the metacarpals and metatarsals. The most celebrated of the great extinct "ground-sloths," *Megatherium*, walked in the same way. It has been surmised that these great sloths sat up on their haunches, supported by their powerful tails, and grasped the trunks of trees with their powerful arms, either wrenching them up by the roots or breaking them short off to the ground, and then fed upon their leaves. *Megatherium* attained a length of eighteen feet, and had bones more massive than those of an elephant. The thigh-bone is nearly thrice the thickness of the same bone in all existing elephants. Now, nothing can be imagined more unwieldy or uncomfortable than for a peculiarly huge and ponderous animal to walk on the outside edges of its bent feet! One must suppose it descended from some arboreal form, of which the modern sloth is a surviving representative; that it was too stupid and heavy to accommodate itself to outward circumstances, and so died out early in the struggle for life.

The Edentata have wofully diminished, both in numbers of species and in size. None survive in Europe, and but one genus survives in Asia—the *Manis*, or scaly ant-eater. Two or three species inhabit Africa, and the rest of the modern Edentata are to be found in South Central America, where in Pliocene and Post-Pliocene times they attained their greatest development. South

America was for a long time parted off from North America by the sea, and probably this circumstance gave these low mammalian forms a chance in the struggle for existence. The higher forms of mammals were prevented from penetrating to the Southern Continent during the ages when the Edentata were taking possession of the country.

The Rodents have diminished both in number of species and in size. A gigantic dormouse has been found in the Maltese Post-Pliocene, described by Falconer as being "as big in comparison to a living dormouse as the Bandicoot rat is to a mouse." The great beaver of the Cave deposits of Europe (*Trogontherium*) differed little from the existing beaver except in its greater size. The large extinct beaver of Ohio (*Castoroides Ohioensis*) attained a comparatively gigantic size, reaching a length of about five feet. Though beaver-like in form, *Castoroides* was nearly allied to the Capyharas, and was the largest of all known Rodents. The Rodents are found fully specialised in the Eocene; therefore, although they show certain affinities with the Marsupials, they must have differentiated from the Marsupial stock before the Tertiary period.

Especially amongst the extinct genera of Rodents we find some remarkable suggestions of Marsupial structure. *Pseudosciurus* and *Sciuridon*, in the character of their teeth, approach the Australian Koala, and *Sciuroides* recalls the phalangers and kangaroo rats. And, on the other hand, one group of the Marsupials, of which the wombat is the only living representative, had incisors growing from persistent pulps, like the incisors of Rodents. In Tertiary times, these Marsupials (*Fossoria*) possessed forms rivalling the tapir in size.

The origin of the Insectivora is still buried in obscurity. Of some of the higher orders of Mammals we can trace the gradual evolution. We can follow up the Ruminants, the Solipedes, the Carnivora, and the Quadrumana to more generalised forms. But the Insectivora belong to one of those old primitive orders whose representatives are found already specialised in the Eocene. Moles and hedgehogs are already found, at this remote period, in a Mammalian pedigree. Not only were they of the true Insectivorous type, but the mole and the hedgehog had learned, even in

those days, to protect themselves by burrowing or developing defensive spines. Another sign of the great age of this order is that the bats, which are insectivora very highly specialised for flight and *with the highest form of placentation*, are also found in the Eocene.

The Insectivora present so many points of affinity with the lemuroids, lemurs, and monkeys, that they were once considered to be humble ancestors of "our noble selves." The type of dentition, consisting of incisors, canines, pre-molars, and molars; the high placental development; the plantigrade mode of walking: all pointed, it was thought, to close relationship. The relationship, no doubt, is close, but it is a collateral one only. Far back in the Eocene of France and the western territory of America and contemporary with already fully-developed insectivorous forms, were some animals with a dentition more specialised, more *human*, than that of the Insectivora. They had affinities with both the true insectivora and the lemurs. *Necrolemur*, *Adapis*, and *Proadapis*, from the Eocene of France, were of distinctively lemuroid type. But the animals with the nearest approach to human dentition have been found in the Lower Eocene of North America. Truly, like Napoleon, had they been worthy to foresee the future, they might have cried, "Moi, je suis ancêtre." In honour of the illustrious line to which they were to give birth, these lemuroids, of the size of a ground-squirrel, have received the appalling name of *Anaptomorphis homunculus.*

The true Insectivora appear to have pursued their placid and unambitious line of life, little changed from Eocene times. So far as I am aware, the extinct families of Insectivora did not attain a larger size than the modern ones, and though many genera have passed away the havoc has not been so great in their ranks as in those of the more highly developed orders of Mammals.

Lastly, the Primates (monkeys, apes, and man) represent an order which has not yet declined in size, or dwindled in number of species. The great *Dryopithecus* of the Miocene of France was an anthropoid ape of large size, but not larger than the great anthropoid apes of the present day. Probably, man owes his survival in Europe to the fact that he alone amongst the Primates is truly omnivorous. With the scarcity or absence of fruit and

grains during the Glacial period, the monkeys and apes of Europe had no chance in the struggle for life, and the rear guard of their retreating army survives only in the carefully-preserved apes of the Rock of Gibraltar.

Man was probably driven by necessity into becoming a carnivorous animal. He hunted and killed the horse, the reindeer, the urus, the mammoth, and the seal; he roasted their flesh and broke their bones for marrow, and finally—to show he was man and not a carnivorous ape—he drew their portraits. These hunting and artistic exploits took place, as is well known, in Post-Pliocene times—the "to-day" of geology, a period well fitted for the appearance of the highest of mammals. But chipped flints, adapted for many purposes and resembling chipped flint implements of low savages at the present day, are to be found in undoubtedly Miocene deposits. Alas! no bone, no organic trace whatever, of the creature that chipped those flints has ever been found. If we ever find fossil traces of "Miocene Man," should we not find a semi-human creature? A being the size of whose brain-case would forbid the idea of his (or its) having used articulate language, which had not learned the use of fire, and whose powerful jaws, required for devouring uncooked food, would have precluded great development of brain. It is difficult to see how man could have become truly man, till the discovery of fire enabled him to eat cooked and softened food. But all this is theory. Much might be done, in fact, if anthropologists would take to heart the lesson that *unprogressive forms are found living side by side with the progressive*, as a form closely allied to the most primitive dogs survives in South America. Miocene man is probably dead and gone for ever, but he may have been the ancestor of two or more branches of the order of Primates, and the lower branch—differing little from its ancestor—may still survive.

I was much struck by the strange story of the Soko, as told by Stanley. He was, whilst in Central Africa, within two days' journey of this great ape, but he did not think it worth while to deviate from his route to find a living specimen. But some heads of the Soko, "*covered with grey fur*," were shown him in the native villages. He sent the skulls home to Professor Huxley, and received this (to me astounding) reply:—"The skulls are

human, and not those of any species of ape." I quote from memory. The thought and the hope have haunted me ever since, "Should we in the Soko find a type resembling Miocene man, or at least more human in brain and in habits than any other anthropoid ape?" But no one else seems to be curious as to what might prove to be the value of an examination of this ape, with a "head covered with grey fur," whose "skull was undoubtedly human"!

The Jackoons of Borneo represent a race of human beings, remarkably simian in appearance and habits, living on platforms built in trees. The account of them, given by "Theresa, Lady Yelverton," was of extreme interest. She went to a wedding of Jackoons, under the auspices of a Roman Catholic priest, and expresses a lively sense of the horror of "seeing monkeys married," and of the grotesque effect of a surpliced choir of these queer aborigines. If Lady Yelverton is not considered a reliable authority, why does not some professional anthropologist go to Borneo and examine these human "monkeys"?

Traditions have existed from the earliest ages of a race of men on the borders of China, with opposable great toes. They are mentioned in the ancient annals of China, and spoken of in modern times, yet no one attempts to see if the tradition is true or false. The Ainos, the hairy aborigines of Japan, are indeed being closely examined before their rapidly-approaching extinction has taken place. And it has been ascertained that the Ainos have so far diverged from the Japanese, that the children of unions between the two races are usually infertile, and die out in the second or third generation. They have, in short, diverged far enough from each other to come under the mysterious law which decrees the sterility of hybrids. Man himself, I believe, was never truly an arboreal animal. He was capable of climbing into trees for safety and building platforms thereon, as he does now. But he was a plantigrade animal, living on the ground, and making a home in caves. I believe that the foot of man represents *a more primitive form* than that of existing apes and monkeys, and that it never passed through the prehensile stage, which is characteristic of the foot of existing lemurs, monkeys, and apes. The great toe is more prehensile with other races of

man than with us, but has never *yet* been found opposable.

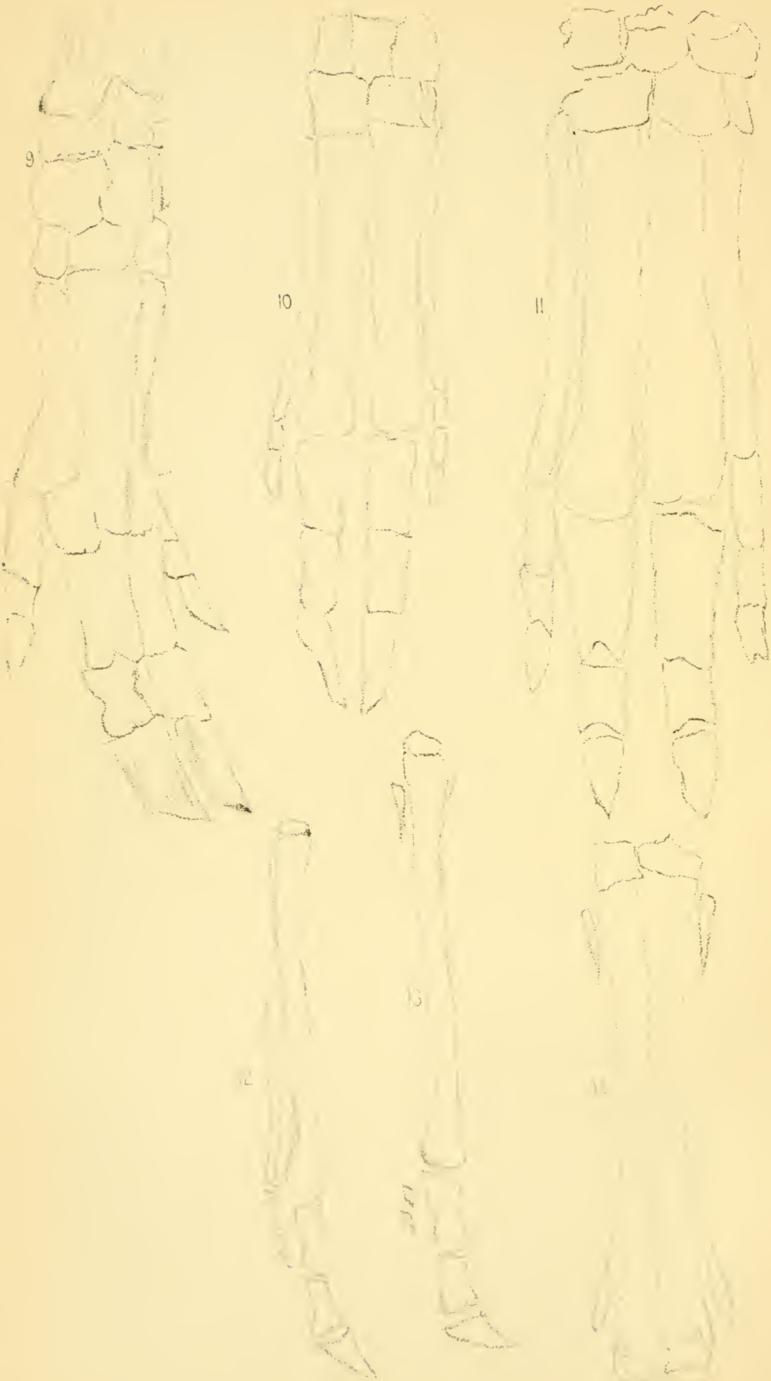
This paper is now drawing to a close. My object in writing it has been to draw the attention of those who are not professed palæontologists, to the profound obscurity in which the laws governing the appearance, duration, and disappearance of species, are still shrouded. Some lowly forms live on through every possible vicissitude. They flourished in the Miocene, and they flourish still. Other low forms disappear with astonishing rapidity, whole orders becoming absolutely extinct. Some highly-specialised forms—high, too, in the scale of intelligence—live on and head the animal kingdom at the present day. Such are the elephants. Others developed rapidly to a very high point of specialisation, only to die out as rapidly. Such forms were *Machairodus* and *Hyœnodon*.

My second object has been the hope that the attention of anthropologists and travellers might be again drawn to the possibility of finding surviving semi-human forms, such as we may imagine Miocene man to have been. For palæontology shows that an animal does not necessarily die out in giving birth to a higher form. The undifferentiated primitive form and the highly-specialised descendant may continue to exist side by side.

Note.—Since writing this paper, I see in the *American Naturalist* for July that Professor Cope, the highest living authority on Mammalian Palæontology, is of opinion that man was derived directly from a lemuroid form, without the intervention of the anthropoid apes. This he infers, not only from the generalised foot of man, but from lemuroid characters in his superior molar teeth. The nearest approach to the original Eocene type from which the hoofed animals, monkeys, and man are descended, is considered by Professor Cope to be *Phenacodus Primevus*.

I may add that Professor Wallace considers that some skulls found lately in Calfornia were possibly of Miocene age (see *Nineteenth Century*, November, 1887.

Phenacodus primævus.


9
10
11

EXPLANATION OF PLATE V.

Phenacodus primævus (Cope) one-seventh natural size. Representative of type believed to be the ancestor of all hoofed mammalia, monkeys, and man. Professor Cope says of the specimen, of which this plate is a copy, that it is one of the most perfect fossils ever discovered, almost all parts of the skeleton being preserved ; and that it is one of the most important to phylogeny, as it represents the type from which most modern mammalia have been probably derived.

NOTES TO PLATES VI. AND VII.*

In the less specialised forms of Ungulates, the metatarsals and metacarpals are not united into the so-called " cannon-bone "; and the superfluous toes are still attached to the carpals, *e.g.* Hipparion, Anchitherium, Sus. In the highly specialised forms, the metacarpals and metatarsals are united into a " cannon-bone," and the superfluous toes are reduced to rudiments, known as " splint-bones," *e.g.*, Horse, Deer.

Fig. 1 and 2.—Early form of Hoofed Animal, with reptilian brain, *Coryphodon hamatus* (Lower Eocene).
,, 1.—Shows the right fore foot with all toes functional.
,, 2.—Outline of Skull and Brain Cavity.
,, 3, 4.—Early form of Horse-like Animal, *Anchithrium aureliense.*
,, 5, 6.—Later form of Horse-like Animal, *Hipparion gracilis.*
,, 7, 8.—True Horse. All from Les Ancêstres de Animaux.
A. Gaudry.
,, 9.—Modern Pig (*Sus*). An unspecialised but long surviving type of hoofed Animal.
,, 10, 11.—Unspecialised forms of Ruminants, living and extinct.
,, 10.—*Hyœmoschus aquaticus* (living).
,, 11.—Hyopotamus (extinct).
,, 12, 13, 14.—Highly specialised forms of Ruminants.
,, 12.—Red Deer.
,, 13.—Common Roe.
,, 14.—Gelocus.

* As these plates only came to hand on the morning of going to press, they cannot be inserted till our next part.

Queries.

1.—Sealing Bottles.—Will some one who has had practical experience in preventing Spirit of Wine evaporating from Natural History Specimens, preserved in Corked Glass Bottles, kindly describe the best method of Sealing to prevent this? Ordinary sealing-wax over the cork soon gets leaky. C. J. W.

2.—Peat—I have read of a new material manufactured in Ireland from top peat. Will someone explain the process?
R. S. V. P.

3.—The Ox Bot Fly, Æstrus bovis.—Thousands of the larvæ of this fly can be taken from the skin on the back of horned cattle any year in our grazing districts, yet the perfect insect is very rare, and cannot be bred from the larvæ unless taken from the tumours just as they are full fed. Have any readers captured the perfect insect (Ox Bot Fly) in England, and if so, would they kindly describe its appearance from a captured specimen, and state whether the sexes differ in size and colour? The specimens of this Fly in our Museums and private collections of Diptera, are usually Continental captures. Entomologist.

4.—Rotifers.—Are Rotifers of any use in removing decayed organic matter, as Infusoria do? M. C. L.

5.—Four-Footed Bird.—In *Science Gossip*, December, 1884, p. 278, an announcement is made of the discovery of a living species of four-footed bird (opisthocoma cristata), from the island of Marajo, in the lower Amazons. Has any further information been published on this subject, and if so in what paper?
Osmanli.

6.—Rock-salt and Gypsum.—Will someone explain the formation of these in the earth? R. S. V. P.

7.—Human Body.—It is usually stated that the body of a man is renewed once in seven years. Will someone criticise this statement? R. S. V. P.

Answers to Queries.

1.—Sealing Bottles.—The following method of sealing bottles, containing Natural History Specimens, preserved in Spirits of Wine, is from one who is "an old hand at this work in the Museum of Newcastle." My friend, in Belfast, who has sent it to me, did not mention his name.—"*No cork is used.*" Steep a bladder in water until it begins to "smell" a little, take it out and stretch it tightly over the mouth of the vessel, tying it with well waxedsmall twine, cut off the surplus bladder, put it away until it dries, paint it over with two coats of white paint, then add a piece of "good

tinfoil" over the paint, then another layer of bladder well stretched over, and cutting off the surplus neatly; when dry, another couple of coats of white paint, and the job is finished. This will keep the specimens all right for a long time. H. W. LETT.

1.—Sealing Bottles.—The following is a good cement for securing bottles containing volatile fluids:—Mix together, Water 2 parts; Glycerine, sp. gr., 1·240, 5 parts; 6cc. of this mixture are incorporated with 50 grammes of litharge. It will harden in an hour. E. J. STUTTER.

2.—Peat.—Peat litter, of a like character to that imported from Germany, has been manufactured in Ireland from the top layers of peat bogs. It is just the ordinary Sphagnum or Bog-moss in a partially decayed state, and is largely used in a few places for stable litter. H. W. LETT.

[We trust that our readers will supply answers to the rest of these questions in time for our next issue.—*Ed.*]

Correspondence.

[The Editor does not hold himself responsible for the opinions or statements of his correspondents.]

To the Editor of "The Journal of Microscopy and Natural Science."

MY DEAR SIR,—

Could not some means be devised to enable members to have slides or material "named" through our Journal? Valuable finds are often neglected, and lost or put to little use on account of the difficulty of identification. We have many members well versed in the different branches of microscopical research; I am sure they would readily give others the help of their experience, and would occasionally benefit by the samples submitted to them, as these would not be generally returned.

I should like to call attention again to the matter of my letter to you in April last concerning the "circles," and which our President so highly approved of in his address. The scheme may seem on paper a little "over-elaborated," but in practice, I think, would work easily and smoothly. At any rate, I think that after the words of the President, and communication with several workers, some such scheme is admitted to be wanted. To start at once to meet this want, I propose that members should send in their names to the Secretary, stating the branch or branches they would like to work in, and being put into communication by him they should be left to work out a method at their own discretion. In our next number, I should like to see at least a list of such

"corresponding circles." Rules would soon be found in actual experience.

E. J. Stutter.

Callowend, Worcester.

[The Editor will be glad to receive the names and addresses of readers of the Journal willing to Name Slides and Specimens, and to furnish Answers to Questions. They should state to which department of Natural History their studies are specially directed. Members of the P.M.S. desirous of forming or joining special sections should communicate with the Hon. Secretary.]

Reports of Societies.

SOUTH LONDON MICROSCOPICAL & NATURAL HISTORY SOCIETY.

The Seventeenth Annual Report of this Society is now before us. It contains Rules of the Society, Catalogue of Books, Treasurer's Statement of Accounts, Abstract of Papers read before the Club, and a List of Members, of which there appears to be nearly 130.

The papers read were of an interesting nature, and we are pleased to notice that the Society possess a very excellent library of books.

THE WESTERN MICROSCOPICAL CLUB.

The Abstract of Proceedings of the Society for the session 1887—8 is before us, from which we learn that it was founded Nov., 1882, and is limited to 20 Active and 20 Honorary Members. The Club has no Committee or Officers except a Secretary, and the meetings are held monthly at the houses of the Active Members. Papers are not usually read at the meetings. The Host of the evening introduces some scientific subject for members to illustrate. Short reports of these meetings are given in the proceedings.

Exchange.

Offered.—*Bingley's* Animal Biography, Vols. 2 and 3 (one cover damaged), 4th edition, 1813; Histoire de l'Empire de Russe, *Voltaire* (paper covers); Histoire de Charles XII., *Voltaire;* L'Avare, Comédie (1667), *Moliere;* Le Misanthrope, Comédie (1666), *Moliere;* Select Fables of *La Fontaine*, with English

notes; La Henriade, *Voltaire; Ingram and Trotter's* Mathematics, 6th edition; Adventures and Traditions, *Glass.*

WANTED.—Phillip's Guide to Geology; McCulloch on Rocks; Phillips' Geology of Yorkshire; De la Beche's Manual of Geology; Hull's Coal-Fields of Great Britain; Woodward's Geology of Norfolk; Lonsdale's Geology of Bath; Darwin's Naturalist's Voyage; Felton's Geology of Hastings; The Konink's Fossil Monograph; McCoy's Fossil Monograph.—J. Smith, Monkredding, Kilwinning.

Reviews.

MANUEL PRATIQUE DE CRYSTALLOGRAPHIE. Par G. Wyronboff. 8vo, pp. xii.—344. (Paris: Gauthier-Villars. 1889.) Price 12 fr.

This book is a manuel for the determination of the forms of crystals, and gives such information as will enable the ordinary student to obtain sufficient practical knowledge of the subject to enable him to dispense with the aid of a specialist.

The aim of the author is to popularise the study of crystallographic calculation among young chemists, a subject to which he has for some length of time devoted his attention.

LETTERS ON LANDSCAPE PHOTOGRAPHY. By H. P. Robinson. 8vo, pp. 94. (New York: The Scoville Manufacturing Co. 1888.) Price $1.50.

These letters, which were originally published in the *Photographic Times*, will be found of great value to those who, by their study and practice of photography, are enabled to produce a technically perfect negative, but who do not know how to put their knowledge to pictorial use. It contains a number of plates. A photographic portrait of the author forms the frontispiece.

PICTURES IN BLACK AND WHITE; or, Photographers Photographed. By Geo. Mason. Cr. 8vo, pp. 188. (Glasgow: Geo. Mason and Co., 180 Sauchighall Street; London: Greenwood and Co., 2 York St., Covent Garden.) Price 1s.

Mr. George Mason—whose writings over the signature of "Mark Oute" are well known—gives us here some interesting pen-portraits and narration of incidents which, he tells us, are true, gathered from his own experience, with just sufficient colouring to give them form.

LA PHOTOGRAPHIE INSTANTANEE, son Application aux Arts et aux Sciences. Par Le Dr. J. M. Eder. Royal 8vo, pp. xiv.—221. (Paris: Gauthier-Villars et Fils. 1888.) Price 6fr. 50c.

This is a very exhaustive treatise on instantaneous photography, giving very full details of the various forms of apparatus employed, and of the methods necessary to obtain series of instantaneous photographs of such objects as trotting horses, leaping, etc. The work is very fully illustrated, and many of the illustrations are of great interest.

PROCEDES PHOTOGRAPHIQUES pour l'Application directe sur al Porcelaine, avec Couleurs Vitrifiables de Dessins, Photographics, etc. Par E. Godard. (Paris: Gauthier-Villars et Fils. 1888.)

A short, practical treatise on the transference to porcelain, etc., of photo-

graphic films. It does not enter into the methods of obtaining the photographic image, but describes the process of transferring it to the porcelain or ceramic plate.

L'HYDROQUINONE : Nouvelle Méthode de Développement. Par George Balagny. (Paris : Gauthier-Villars et Fils. 1888.)

The investigations of the student of organic chemistry are constantly bringing under our notice compounds whose properties, as well as their excellence, were previously unknown. These properties are the objects of much interest in a great variety of ways, and it is no wonder that experimental photographers are among the first to take a lively interest in these new compounds, The compound to which attention is called in this little *brochure* is one closely allied to pyrogallic acid, and its action as a reducing agent of the silver salts is very similar, but the author claims for it greater certainty of action, greater rapidity, and better results; and he points out very clearly the conditions of success.

DIE BROMSILBER-GELATINE Ihre Bereitung und Anwendung zu Photographischen Aufnahmen zu Abdrücken und zu Vergrösserungen. Von Dr. Paul E. Liesegang. 8vo, pp. 198. (Dusseldorf: Ed. Liesegang's Verlag. 1889.)

In the work before us, Dr. Liesegang gives an exhaustive treatise on the Gelatine-Bromide progress in Photography ; the book is illustrated with 71 well-executed engravings.

PHOTOGRAPHISCHER ALMANACH und Kalender für das Jahr 1889. (Dusseldorf: Ed. Liesegang's Verlag.)

This little Annual of 136 pages contains a large amount of useful information and practical receipts. We notice a large margin is left on the pages containing receipts for notes, which will doubtless be found convenient. The book contains portraits of Edward L. Wilson, and of Louis Jacques Maude Daguerre.

THE ART AND PRACTICE OF SILVER PRINTING. By Capt. Abney and H. P. Robinson. 12mo, pp. viii.—136. (London : Piper and Carter. 1888.) Price 1s. 6d.

This little work, now in its Second edition, goes very thoroughly into the subject of which it treats, and by careful attention to the instructions laid down by the authors, we feel assured the operator will be enabled to secure not only beautiful, but permanent results.

GEORGE MASON AND CO.'S PHOTOGRAPHIC GUIDE. (Glasgow: G. Mason and Co., 180—186 Sauchiehall Street.)

This work of 272 pages is composed largely of Trade Catalogue, in which full directions are given for using all the various apparatus, of which there are nearly 340 illustrations. There will also be found a considerable amount of instruction, making the book valuable either to the Professional or Amateur.

THE PHOTOGRAPHER'S BOOK of Practical Formulæ. Compiled by W. D Holmes, Ph.B., and E. P. Griswold. Crown 8vo, pp. 240. (New York : P. A. McGeorge. 1888.)

The editors tell us that in compiling this work their chief aim has been not so much to procure new matter, although much that is new and useful has been added, as to publish in a compact form all the old formulæ now in successful and daily use.

THE ANIMAL WORLD. Vol. 19. (London: S. W. Partridge and Co. 1888.) Price 2s. 6d. and 4s.

This Advocate of Humanity is issued by the Royal Society for the Prevention of Cruelty to Animals. It is a magazine which we always read with much pleasure. The tales and illustrations are thoroughly good.

DIE NATURLICHEN PFLANZENFAMILIEN, nebst ihren Gattungen und wichtigeren Arten insbesondere den Nutz plaezen bearbeitet unter Mitwirkung zahbreicher herverragender Fachgelchrten. Von A. Engler und K. Prantl.

We are in receipt of parts 16—23 of this valuable botanic work, which comprise the following families :—

Mymphacaceæ, by R. Caspary, Ceratophyllaceæ, Lactoridaceæ, Philydraceæ, Ulmaceæ, Moraceæ, Urticaceæ, Proteaceæ, and Burmanniaceæ, by A. Engler. Magnoliceæ, Trochodendraceæ, Anonaceæ, Myristicaceæ, Ranunculaceæ, Fagaceæ, Menispermaceæ, and Calycantaceæ, by K. Prantl; Bromeliaceæ, by L. Wittmach; Commelinaceæ and Pontederiaceæ, by S. Schonland; Iridiaceæ Monimiaceæ, by F. Pax; Musaceæ, Zingiberaceæ, Cannaceæ, and Marantaceæ, by O. G. Petersen, and Orchidaceæ, by E. Plitzer. These eight parts contain 4 plates and 289 engravings, composed of 1,216 figures. The illustrations are in the best style.

THE FROG: An Introduction to Anatomy, Histology, and Embryology, By Prof. A. Milnes-Marshall, M.D., D.Sc., M.A., F.R.S. Third edition, revised and illustrated. Crown 8vo, pp. viii.—146. (Manchester: J. E. Cornish; London: Smith, Elder, and Co. 1888.) Price 6s.

This is an admirable elementary work, and one which we can recommend any student to commence his zoological studies with. It is throughout thoroughly practical, and its carefully-tabulated form makes it very convenient for referring to any section. The illustrations are well executed and clear. It is essentially a practical book, and anyone who conscientiously works through it will secure an excellent ground-work upon which to continue his studies.

STORIES AND PICTURES OF ANIMAL LIFE, with a Few Words concerning Plants. By James Weston. Crown 4to, pp. 96. (London: S. W. Partridge and Co.)

A nicely-illustrated and well-got-up little work for young people. It treats of a variety of subjects. Amongst many others there are chapters on Water-Beetles, Ant-Bears, Ship-Worms, Plants that Catch Flies, Toads, Sea-Urchins, Wasps and their Nests, Caddis-Worms, the Walking Leaf, etc. etc. The illustrations are numerous and very good.

THE ZOO. By the Rev. J. G. Wood. Crown 4to, pp. iv.—92. (London: The Society for Promoting Christian Knowledge.) Price 2s. 6d.

Contains a number of interesting chapters on the Orang-Outang and Chimpanzee, Monkeys, Bats, Lions, Tigers, Leopards, and very many others. Some of the illustrations are coloured.

ANECDOTES IN NATURAL HISTORY. By the Rev. F. O. Morris, B.A. Crown 4to, pp. 112. (London: S. W. Partridge and Co.) Price 2s.

A handsomely got-up volume, with beautifully engraved illustrations, well suited as a present for a good boy or girl. The anecdotes are very interesting.

The Charterhouse Atlas. 4to. (London: Relfe Bros.) Price 1s. and 1s. 6d.

Consists of twenty-one maps, arranged to show all the principal Towns, Rivers, Mountains, and Places mentioned in the "Oxford and Cambridge Geography." The maps are distinctly drawn and neatly coloured. That of the British Isles shows the principal lines of railways. The names are not so crowded as to be indistinct or confusing.

Truth for its Own Sake: The Story of Charles Darwin, written for Young People. By W. Mawer, F.G.S. Crown 8vo, pp. iv.—131.

This is, in fact, "A Life of Charles Darwin," and gives a most interesting account of the great naturalist from the cradle to the grave. We highly commend the book to our young naturalist friends, by whom we are sure it will be read with much profit.

Land and Fresh-Water Shells: An Introduction to the Study of Conchology. By J. W. Williams, M.A., D.Sc., F.S.L.A., etc. Crown 8vo, pp. 112. (London: Swan Sonnenschein and Co. 1889.) Price 1s.

This capital volume of the "Young Collector Series" treats of Collecting and Preserving Snails, Mussels, and Slugs; the Anatomy and Physiology of the Snail and of the Fresh-water Mussel; the Classes, Orders, Families, Genera, Species, and Varieties of British Land and Fresh-Water Snails. It has also a chapter on the Distribution of the British Land and Fresh-Water Mollusca, by J. W. Taylor, F.L.S., and W. Denison Roebuck, F.L.S. It is well illustrated.

An Introduction to Entomology. By John Henry Comstock. 8vo, pp. iv.—234. (Ithaca, N.Y. [U.S.A.]: Published by the Author. 1888.)

A study of this work will enable the student to acquire a thorough knowledge of Entomology, and to classify insects, and readily determine to what family any insect of which he has a specimen belongs. The pronunciation of the technical words is indicated by marking the accented vowel, and at the same time indicating its length when the term is pronounced as an English word. It is illustrated with four full-paged plates and 200 figures drawn and engraved by Anna Botsford Comstock.

Animal Memoirs. Part 1, Mammals. By Samuel Lockwood, Ph.D. Post 8vo, pp. xvii.—317. (New York: Ivison, Blakeman, and Co.)

A series of 25 chapters of Anecdotes and Natural History facts about the Mammalia, under the titles of Animal Humour; Queer Animals; Hidden Meanings; Eccentric Animals; Mammals that lay eggs; and a host of others. The book, written in understandable language, is very instructive and entertaining.

Nature's Fairy Land; or, Rambles by Woodland, Meadow, Stream, and Shore. By H. W. S. Worsley-Benison. (London: Elliott Stock. 1889.) Price 5s.

We are pleased to learn that a Second Edition of this most interesting work is now ready. It is handsomely bound with gilt edges, and well illustrated.

The Invisible Powers of Nature. By E. M. Caillard. Post 8vo, pp. xix.—252. (London: John Murray. 1888.) Price 6s.

This, to the young student of Nature, will be found a most interesting and instructing book. It treats in a very plain and comprehensible manner of Gravitation, Molecular Attraction, Properties of Solids, Liquids and Gases, Heat, Light, Sound, Electricity, Magnetism, etc.

CHEMICAL LECTURE NOTES, taken from Prof. C. O. Curtman's Lectures at the St. Louis College of Pharmacy. By H. M. Whelpley, Ph.G. Crown 8vo, pp. 211. (St. Louis, Mo., U.S.A.: The Author. 1888.)

We have here the Second edition very considerably enlarged of this useful work. It is divided into two parts: the first, "Chemical Physics," is divided into 21 sections, and is illustrated by 100 neatly engraved figures. The other section is devoted to "Chemistry" proper, and consists of 103 sections. Pharmaceutical and Medical students will doubtless find these notes helpful.

THE STAR ATLAS, with Explanatory Text. By Dr. Hermann J. Klein; translated and adapted for English readers. By Edmund McClure, M.A., M.R.I.A. 4to, pp. viii.—72. (London: The Society for Promoting Christian Knowledge. 1888.) Price 7s. 6d.

This excellent Atlas contains 18 maps printed by E. A. Funke, Leipsic showing all the stars from 1 to 6·5 magnitude between the North Pole and 34° South Declination, and all Nebulæ and Star Clusters in the same region, which are visible in telescopes of moderate powers. The maps are of large size, each map being the size of two pages of the book, and mounted on guards, so that each map opens perfectly flat. The Stars are printed their relative sizes in black ink, whilst to prevent confusion, and for greater clearness, the names of the Stars and Constellations are printed in red ink.

MOVEABLE TROPIC DIAGRAM OF THE SEASONS. (Edinburgh and London: W. and A. K. Johnstone. 1888.) Price 10s.

A most ingenious and convenient chart, invented and constructed by John W. Mason, of Edinburgh; it consists of a circular map of the Northern regions, extending Southwards to a little below the British Isles; in the centre of the chart the map is continued Southward to a little below the Tropic of Capricorn; and in a groove extending from the North to the South Tropic, a brass representation of the Sun is arranged to slide. This, in moving, carries with it, at the upper part of the circular map, a black shadow, showing the length of day and night in the Northern regions, the time of the rising and setting of the sun at London, and its situation, with respect to the Equator and Tropics on any given date.

MEMORY: Its Logical Relations and Cultivation. By F. W. Edridge-Green, M.D. Crown 8vo, pp. iv.—274. (London: Bailliere, Tindall, and Cox. 1888.)

This work offers to every teacher and student a scientific and practical treatment of the subject of memory and its cultivation; it is divided into two parts. The first treats of Sensory and Motor Memory; the Faculties of the Mind; Special Memories; Memory in the Lower Animals; the Variations of Memory at different periods of life; the Localisation of Memory, etc. etc. Part 2 treats more particularly of the Cultivation of the Memory, for which twenty-one rules are given. These rules are practical and generally applicable, because they are based on functions which are the same in all, and can even be utilised for the purpose of teaching animals, and very considerably in the education of children. We can confidently recommend this book to all engaged in the work of teaching.

Anatomy of the Upper Extremity. Post 8vo, pp. 64. (Edinburgh : E. and S. Livingstone. 1889.) Price 1s. 6d.

The information conveyed in this one of Livingstone's Medical Handbooks is in the form of Questions and Answers. The small and convenient size of the book and the concise manner in which the answers are given will make it useful to the student about to pass his examination.

Health Lectures, delivered in Manchester, 1886, '87, '88. (London and Manchester : John Heywood.)

This volume contains the 10th and 11th series of the Health Lectures for the People, each series consisting of eight lectures, given, in popular language, by members of the medical profession.

The Physician's Leisure-Hour Library. (Detroit [Mich.], U.S.A. : Geo. S. Davis. 1886, '87, '88.)

A valuable series of volumes, published monthly, at the price of 25 cents., addressed exclusively to the Medical Profession. Each volume is written by a specialist on the subject of which it treats. The size of the volume is foolscap 4to, and varies in extent from about 60 to 200 pages. The subjects which have been discussed up to date are :—

The Modern Treatment of Eczema. By H. G. Piffard, M.D.

New Medications. By Du Jardin Beaumetz, M.D. ; translated by E. P. Hurd, M.D. Two vols.

The Use of Electricity in the Removal of Superfluous Hair, and on the Treatment of Blemishes. By G. H. Fox, M.D.

Spinal Irritation. By William A. Hammond, M.D.

The Modern Treatment of Ear Diseases. By Samuel Sexton, M.D.

Granular Lids and Contagious Ophthalmia. By W. F. Mittendorf, M.D.

Antiseptic Midwifery. By H. J. Garrigues, M.D.

The Physiological, Pathological, and Therapeutic Effects of Compressed Air. By Andrew H. Smith, M.D.

Inhalers, Inhalations, and Inhalants. By Beverley Robinson, M.D.

On the Determination of the Necessity for Wearing Glasses. By H. B. St. John Roosa, M.D.

Practical Bacteriology. By Thomas E. Satterthwaite, M.D.

Pregnancy, Parturition, and the Puerperal State, and their Complications. By Paul F. Mundé, M.D.

The Treatment of Hæmorrhoids. By Charles B. Kelsey, M.D.

Diseases of the Heart. Two vols. By Du Jardin Beaumetz, M.D. ; translated by E. P. Hurd, M.D.

Diarrhœa and Dysentery : Modern Views of their Pathology and Treatment. By A. B. Palmer, M.D.

Intestinal Diseases of Children. By A. Jacobi, M.D.

Modern Treatment of Headaches. By Allan McLane Hamilton, M.D.

Modern Treatment of Pleurisy and Pneumonia. By G. M. Garland, M.D.

Infectious Diseases. Two vols. By Karl Liebermaister ; translated by E. P. Hurd, M.D.

Diseases of the Male Urethra. By Fessenden Otis, M.D.

The Disorders of Menstruation. By Edward W. Jenks, M.D.

Clinical Lectures on Certain Diseases of the Nervous System. By J. M.

Charcot, M.D. ; translated by E. P. Hurd, M.D.

The Theory and Practice of the Ophthalmoscope. By John Herbert Claiborne, junior, M.D.

Diseases of the Liver. By Prof. Du Jardin Beaumetz ; translated by E. P. Hurd, M.D.

Abdominal Surgery. By Hal C. Wyman, M.D.

Hysteria and Epilepsy. By J. Leonard Corning, M.D.

These books are nicely got up, and where necessary are well illustrated. They will prove a welcome addition to the physician's library. We should have stated that in order to keep the series within the price stated they are bound in stiff-paper covers.

THE ILLUSTRATED MEDICAL NEWS. (London : 13 Warwick Lane.)

This fine work, which was commenced on Sept. 29th last, is addressed only to members of the Medical Profession, and consists of the following departments :—Clinical Notes ; Original Articles ; Leaders ; Special Correspondence ; Lectures ; Public Health Department ; Reviews ; Addresses ; Weekly Notes, etc. etc. The size of the pages is 14 by 10 inches. Each number contains a full-size coloured plate and a number of wood engravings, photo-mechanical prints, and other illustrations. The price is 6d. weekly, and being registered as a newspaper may be obtained direct from the publishers at 6½d.

THE ANATOMY OF SURGERY. By John M'Lachlan, M.B., M.R.C.S. 12mo, pp. xv.—768. (Edinburgh : E. & S. Livingstone. 1887.) Price 10s. 6d.

This useful work is intended for students about to pass the various higher examinations, and more especially for those examinations which require actual operations on the dead body as part of the Final or Pass Examination.

It is illustrated with 74 full-plate and other engravings.

A MANUAL OF FRUIT AND STILL-LIFE PAINTING in Oil and Water-colours from Nature. With three illustrations. By W. J. Muckley. Third Edition. 12mo, pp. 80.

A DESCRIPTIVE HANDBOOK OF WATER-COLOUR PIGMENTS, illustrated with seventy-two water-colour washes, skilfully gradated by hand on Whatman's Drawing Paper. With an Introductory Essay on the recent Water-Colour Controversy. By J. Scott Taylor, B.A. Fourth Edition. 12mo, pp. 70. (London : Winsor and Newton, Rathbone Place, W.) Price 1s. each.

Two of the excellent little Handbooks on Art published by this well-known firm. Each treats very fully of its own particular subject.

WONDERS OF ACOUSTICS. From the French of Rodolphe Radau ; the English revised by Robert Stawell Ball, M.A. Fourth Edition. Crown 8vo, pp. viii.—243.

WONDERS OF ANIMAL INSTINCT, with Illustrative Anecdotes. From the French of Ernest Menault. Sixth Edition. Crown 8vo, pp. xiv.—336. (London : Cassell and Co.) Price 1s. each.

Two of Cassell's "Library of Wonders" series, containing a large amount of useful and most interesting information ; they are both well illustrated.

EASY LESSONS ON LIGHT. By Miss Adams. (London : Relfe Bros. 1888.) Price 9d.

In this little book of 42 pages, the author attempts to explain the leading

principles of light by diagrams, and by reference to objects of common use. It is illustrated with 22 diagrams, and a great deal of information is given in an easy and pleasant manner.

A CLASS-BOOK OF ELEMENTARY CHEMISTRY. By W. W. Fisher, M.A., F.C.S. Crown 8vo, pp. xv.—272. (Oxford and London: The Clarendon Press. 1888.)

The author gives the student an account of the most important chemical phenomena, actions, and changes, with the laws of chemical combination, and the theoretical explanations of these laws. In the earlier chapters Water and Air are treated in detail; these are followed by chapters on the Elements, Carbon, Sulphur, Chlorine, Nitrogen, Phosphorus, etc. The metals are treated in outline, and only their important and characteristic compounds touched upon. The work is illustrated with 60 engravings on wood.

PRIMARY METHODS IN ZOOLOGY TEACHING: For Teachers in Common Schools. By W. P. Manton, M.D., F.R.M.S., F.Z.S., etc. 16mo, pp. 61. (Boston [U.S.A.]: Lee and Shepard. 1888.) Price 50c.

This little book—which is one of the series of Dr. Manton's "Practical Helps in Natural History"—supplies a few practical points and methods which the author has found of service, and outlines showing how these methods may be utilised in instructing the youngest pupils. The sketches, which are purposely roughly executed, are intended to be reproduced on the black-board by the teacher. It treats of the General Characteristics of an Animal; Bones; Muscles; Blood and Circulation; Respiration and Respiratory Organs; Digestion and Digestive Organs; and the Brain and Nerves.

THE BREAKFAST-TABLE SERIES. By Oliver Wendell Holmes. Crown 8vo, pp. iv.—183 + 191 + 223. (London: George Routledge and Sons. 1888.)

The publishers have given us, in a compact form, the three great works of Dr. Oliver Wendell Holmes. They are:—The Autocrat at the Breakfast-Table; The Professor at the Breakfast-Table; and The Poet at the Breakfast-Table. The introduction is written by George Augustus Sala. An excellently engraved portrait of the author forms the frontispiece to the book. The work is one of the series of Routledge's Library of Standard Authors.

THE PIED PIPER OF HAMELIN. By Robert Browning. Illustrated by Kate Greenway. Demy 4to, pp. 64.

This is a handsomely illustrated edition of this well-known ballad. The illustrations, which are very effectively coloured, are well executed, every attention having been paid to each incident in the tale.

THE WORLD OF ADVENTURE. Illustrated; pp. 64. (Cassell and Co.) Monthly, price 7d.

No. 1 of this new serial is to hand. It promises to give true stories of all ages and widely differing character, but all possessing the romantic element. These stories will be of the most vivid character. "Soldiers, sailors (and, indeed, 'tinkers and tailors'), travellers, firemen, detectives, pirates, buccaneers, privateers, smugglers, bandits, knights of the road, wearers of the Victoria Cross, *chevaliers d'industrie*—all shall walk in its pages." We cordially wish it every success.

ILLUSTRATIONS: A Pictorial Review of Knowledge. Conducted by Francis George Heath. Crown 4to, pp. 380. (London: W. Kent and Co. 1888.)

The bound volume of "Illustrations," with its 300 choice original engravings, is now before us. It contains a series of articles on The Months, Art, Biography, Economy, Invention, Literature, and Science. Its reading matter is instructive, and the engravings artistic and good; we think we may say that the artistic taste of the editor is displayed in every page. "Illustrations" is published monthly at 3d.

EVERY BOY'S ANNUAL. Edited by Edmund Routledge, F.R.G.S. Royal 8vo, pp. vi.—570. (London: Geo. Routledge & Sons. 1889.)

This is, we find, the 27th volume of this very interesting Annual, and although it is to be the last of the series it is by no means the worst. The tales, short stories, and papers are, as usual, of a most interesting character, and the illustrations are good. We learn that, in future, "Every Boy's Magazine" will be incorporated with THE BOY'S OWN PAPER, and published in weekly and monthly parts by the Religious Tract Society.

THE WORKS OF HUBERT HOWE BANCROFT: Native Races. Vol. III. 8vo, pp. xii.—796. (San Francisco: The History Publishing Co. 1886.)

We have before us the third volume of this interesting and voluminous historical work. In Vol. I. we were made acquainted with the Wild Tribes; Vol. II. treated of the Civilised Nations; and in this volume we have an account of their religion, together with a large amount of information respecting their Myths and Languages. We are informed that at the time of the landing of the Spaniards on the soil of the Western Continent there was not a nation who did not recognise the existence of a supreme Deity and Arbiter of the universe, although their religion was fearfully mixed up with idolatry, and in the city of Mexico 70,000 human sacrifices were annually offered. In this volume, also, the languages of the region, some 600 in number, are classified and analysed.

ORNAMENTAL WATERFOWL: A Practical Manual of the Acclimitisation of the Swimming Birds. By the Hon. Rose Hubbard. Crown 8vo, pp. ix.—208. (London: Simpkin, Marshall, and Co. Walsall: W. H. Robinson. 1888.) Price 5s.

The author of this attractive little volume is a well-known writer to several periodicals and papers under the signature of "Henwife." It contains descriptions of 130 species of Swimming Birds, with hints on their management, food, breeding, diseases and accidents, pinioning, and exhibiting.

OUR HOME, OUR PETS, AND OUR FRIENDS. (London: Geo. Routledge and Sons.)

A handsome volume of pretty verses, by Mrs. Sale Barker, beautifully illustrated by A. W. Cooper, Paul Hardy, and F. A. Fraser. We know of no nicer book as a present for our young friends. The illustrations are most pleasing and effective.

A CHAPTER IN ENGLISH CHURCH HISTORY. Edited by Edmund McClure, M.A. 8vo, pp. vii.—375. (London: Society for Promoting Christian Knowledge. 1888.) Price 5s.

The work before us consists of the Minutes of the Society for Promoting Christian Knowledge for the years 1698—1704, together with abstracts of Correspondents' Letters from Nov., 1699, to Nov., 1701, and gives a fair idea of the state of the Church of England at that time, in addition to a considerable amount of information on the condition of society generally.

THE WOMEN OF ISRAEL ; or Characters and Sketches from the Holy Scriptures and Jewish History. By Grace Aquilar. Crown 8vo, pp. 576. (London : George Routledge and Sons. 1889.) Price 3s. 6d.

The work, written by a Jewess for Jewish Women, attempts to illustrate the Past History, Present Duties, and Future Destiny of the Hebrew Females, as based on the Word of God. It is divided into seven Periods, and treats—1, of the Wives of the Patriarchs ; 2, the Exodus and the Law ; 3, the Period between the Delivery of the Law and the Monarchy ; 4, the Monarchy ; 5, Babylonian Captivity ; 6, Continuance of the Second Temple ; and 7, Women of Israel in the Present as influenced by the Past.

ESSAYS ON GOD AND MAN ; or, a Philosophical Enquiry into the Principles of Religion. By the Rev. Henry Irwin Bray, M.A., B.D., LL.D., Rector of Christ Church, Boonville, M.O., U.S.A. 8vo, pp. ix.—270. (St. Louis : Nixon-Jones' Printing Co. 1888.)

In the preface of this unique work the reader is plainly told what startling avowals the author is prepared to enunciate. He tells us that men are everywhere drifting away from the old beliefs, and that the intellect of the world has "lost all faith in the Church of the past." He states that he has faith in the reality and permanence of religion, and hopes in a measure to lead his readers to discriminate between the evanescent and the permanent, between temporal and eternal, and that whilst they may doubt and reject the one, they should not reject the other.

We have read the book with much interest, but think that the author has laid too much stress on the negative side of the Christian religion, as we have it revealed to us in the New Testament.

IS THERE ANY RESEMBLANCE BETWEEN SHAKESPEARE AND BACON ? (London : Field & Tuer. 1888.)

In this volume, Bacon and his biographers are freely quoted in order to show that in every quality he was the very opposite of Shakespeare. Examples are also given of verses which Bacon *did* write, but which, the author says, his present champions studiously ignore.

NOTES FOR BOYS (and their Fathers) on Morals, Mind, and Manners. By an Old Boy. 12mo, pp. 213. (London : Elliot Stock.)

A series of ten chapters on Unselfishness, Truth and Honesty, Courage and Manliness, Energy and Perseverance, etc., which every young man, or old man either, may read with profit.

THE SPIRIT OF BEAUTY ; Essays Scientific and Asthetic. By Henry W. Parker. (New York : John B. Alden. 1888.)

Professor Parker is well known in America as a writer in the *North American Review* and other Journals. The first two papers in this book were read in substance to the Iowa Association for Scientific Research, and are here extended and popularised. They are believed to be the first attempt to review thoroughly, though in a condensed form, the asserted facts on which the figments of brute reason and taste have of late been founded. The title of the first is Beauty and Beast ; the second, Mind in Animals.

LIFE OF WILLIAM CONGREVE. By Edmund Gosse, M.A. 12mo, pp. 192—ix.

LIFE OF JOHN BUNYAN. By Edmund Venables, M.A. 12mo, pp. 195—xxxv.

LIFE OF HEINRICH HEINE. By William Sharp. 12mo, pp. 218—xvii.

These are three Vols. of the "Great Writers" series, and are edited by Professor Erie S. Robinson, M.A. Besides the lives of these great men, each volume contains exhaustive Biographies of their works, by John P. Anderson, of the British Museum.

THE BAIRN'S ANNUAL. Edited by Alice Corkran. 8vo, pp. 136.

THE DAME AND HER DONKEYS FIVE. (London: Field & Tuer. 1888.) Price 1s. each.

Two of the old-style books for which Messrs. Field & Tuer are so famed. The first consists of Old-Fashioned Fairy Tales, etc.; it has a coloured frontispiece and nearly 100 quaint original wooden blocks. The other is embellished with thirty-one Hand-coloured old-time engravings. Both are very amusing, and are sure to please the young people.

MEN, MAIDENS, AND MANNERS of a Hundred Years Ago. By John Ashton. Oblong crown 8vo, pp. 124. (London: Field & Tuer. 1888.)

This book, with its 34 quaint engravings, consists of twelve chapters, a chapter being devoted to describing events occurring in each month about a century ago. It gives a somewhat exaggerated, but at the same a fair idea of fashion in the days of the period.

PEOPLE WE MEET. By Charles F. Rident. Illustrated by Harry Parkes. (London: Field and Tuer.)

Twenty-four very amusing pen-and-pencil sketches.

THE HIEROGLYPHIC BIBLE. (London: Field & Tuer. 1888.)

This is a reprint of a book published in London in 1819. It consists of a selection of verses from the Old and New Testaments, and is embellished and illustrated with hundreds of engravings on wood. We well remember having such a book for a Sunday reading-book about fifty years ago.

PERSIA. By S. G. W. Benjamin. Large crown 8vo, pp. xiv.—304. (London: T. Fisher Unwin. 1888.) Price 5s.

This is one of the "Story of the Nations" series. It gives a History of Persia as it has been, and offers a narrative of the most noteworthy characters and events of that ancient empire from its foundation in prehistoric times. The work is handsomely got up and illustrated with 55 good engravings.

NUMBERS SYMBOLIZED: An Elementary Algebra. By David M. Sensenig, M.S. Crown 8vo, pp. xi.—364. (New York: D. Appleton and Co. 1889.)

Professor Sensenig's book is the outgrowth of twenty years' experience in teaching mathematics to his pupils, and possesses many special features of interest likely to commend it to the consideration of teachers. Its scope includes all subjects essential to a study of higher arithmetic, elementary geometry, and the elements of physics. In the earlier lessons, fundamental ideas and principles are developed inductively, and then formulated into as simple and concise statements as is consistent with truth.

OXFORD, CAMBRIDGE, AND LONDON Arithmetic Questions from Stewart's Home and Class-Book of Arithmetical Questions. By John Stewart. (London: Relfe Bros.) Price 1s. 6d.

Being No. 17 of "Stewart's Examination Manuals," and consists of the various Tables; Oxford and Cambridge Worked-out Examples; London University Papers; College of Preceptors; Oxford, 1864 to 1884; Cambridge, 1864—1884; and Answers to above.

ALGEBRA to Simple Equations. By John Stewart. Third Edition. 12mo, pp. 241. (London: Relfe Bros.) Price 2s. 6d.

This is No. 12 of "Stewart's Examination Manuals," and consists of a series of Graduated Questions and Examination Papers chiefly Factors, Fractions, and Simple Equations. The author gives here a large number of graduated examples under each rule, and in each section will be found questions in all the rules preceding that which the student will next study. This edition has been revised, and the accuracy of the answers tested by H. E. Turner, B.A.

BAND OF MERCY. Vol. 10. (London: S. W. Partridge & Co. 1888.) Price 1s. and 2s.

A handsomely bound and very interesting volume for young people, issued by the Royal Society for the Prevention of Cruelty to Animals. It is full of capital illustrations.

EPHEMERIDES. The Dayes of the Yeare 1889. (London: Unwin Brothers, Little Bridge Street.) Price 6d.

"A London Almanack in the Old Style," has large heavy ornamental borders to the pages, and several quaint woodcuts. We are, however, disappointed to find the "Olde Style" of spelling is not adopted.

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58 SHORT STORIES from American Sources. 8vo, pp. 191. (London: Saxon & Co., 23 Bouverie St. 1888.) Price 1s.

Very readable stories, by well-known American Authors. A suitable companion for a long railway journey.

THE INNER HOUSE. By Walter Besant. (Bristol: J. W. Arrowsmith. London: Simpkin, Marshall, & Co. 1888.) Price 1s.

In this Christmas Annual the writer is looking very far ahead in the world of Science. A splendid vein of irony runs through its entire length.

VANE'S INVENTION: An Electrical Romance. By Walter Milbank. 16mo, pp. 151—vii. (London: Walter Scott. 1888.) Price 1s.

Another novel, in which the writer far outreaches science; the incidents are well put together, and the tale is deeply interesting.

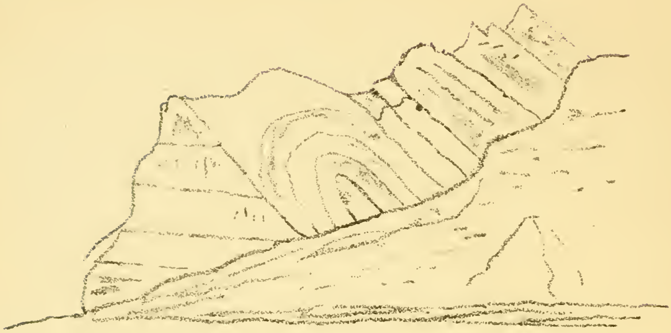
AMATEUR WORK. (London: Ward, Lock, and Co.)

A new series of this useful periodical was commenced in December last. The folding plate which accompanies the part is a pretty fretwork design (full size) for a Blotting Book cover.

We have received from Mr. H. Vial, of Crediton, Devon, Preparer of Anatomical, Pathological, and Botanical Objects for the Microscope, a beautifully mounted slide of Pleuro-Pneumonia from Lung of Cow. It is mounted on slip 1½ by 3 inches, under 1¼ inch cover glass, which it fairly fills. The object is cut exceedingly thin and is nicely stained. We are informed that the price of this slide is 1s. 6d.

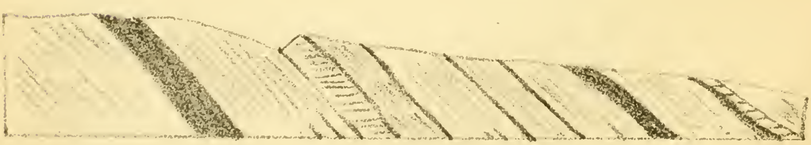
RESEARCH. Edited by A. Norman Tate, F.I.C., F.C.S., F.G.S., F.R.M.S., etc.

The last three numbers of this new journal have contained fine portraits of the late Mr. Richard A. Proctor, F.R.A.S., Sir John Lubbock, Bart., and Mr. James Davis, F.G.S., F.L.S., F.S.A., etc. The price of "Research" is threepence monthly.



Overturned Anticlinal of Limestone Rocks; Cascade Coal Basin

Diagramatic Section across Cretaceous Basin, near Cascade Station.



Section across Cascade Coal Basin, South of Bow River.

Romance of Geology in the North West of Canada.

By Mrs. Alice Bodington.

Plate VIII.

IT may seem strange to apply the term "romance" to so stern a science as that of Geology. But if the word romance may be applied to that which delights the mind, whilst it stimulates and excites the imagination, then may it fitly be applied here.

Not many months ago, I journeyed along the Canadian Pacific Railway from Quebec to its furthest Western Terminus at Vancouver, and much I wondered what had been the past history of the vast regions we passed through. Of course, I knew that the bleak and barren hills on either side of the vast St. Lawrence contained in their strong breasts the oldest rocks in the world, and that along the Great Lakes, rocks only less ancient were to be found—Huronian, Silurian, and Cambrian. But I knew nothing of the past history of the great prairie, stretching for a thousand miles, from Winnipeg to the foot of the Rocky Mountains, nothing of the Rocky Mountains themselves, nor of that lonely Switzerland of the New World which we call British Columbia.

Arrived at Vancouver, I saw a peninsula utterly cleared and stripped of its trees for a space of some three miles square by the fire which had destroyed the newly rising town in 1886. Clumps of beautiful ferns and exquisite mosses clung about the blackened stumps of the burnt pines, which seemed as if they strove to hide the desolation. A very small portion only of the cleared site was occupied by the new city of Vancouver, and where one of its principal streets now runs, the virgin forest had stood but two years ago. The town stands on an arm of the sea, so land-locked that it resembles a lake; mountains—some snow-capped, some wooded to their summits—appear to come down almost to the water's edge.

During my first walk, I noted that the soil was clay, with deposits of sea-sand here and there ; and more or less embedded in the clay were smooth granite and syenite boulders, some of immense size. I heard, too, at the hotel, that in sinking for wells the workmen had to dig through the clay till they came to a bed of sand and gravel. Evidently the peninsula of Vancouver was covered with boulder clay, and I saw before me the debris left by a great glacier. How great this glacier had been I had no idea, till I read, in the Geological Reports of Canada, the paper by Dr. George Dawson, on the Geology of British Columbia. The Straits of Georgia, between the Mainland and Vancouver Island, are about the width of the sea between England and Ireland and these straits were once filled by a stupendous glacier, which has left its traces on the rocks of both sides of the Channel. Imagine a glacier, from seventy-six to eighty miles wide, ploughing its way along till it found, both to the North and South, an outlet to the Pacific.

In the first glacial age, a pall of ice covered all but the highest peaks of the Rocky Mountains. Five thousand feet above the present level of the sea, the glaciers bore with them huge rocks, which are left behind as mute witnesses of the giant force of ice. The depressions and elevations of the land have been very great in this region. The mountains of Vancouver Island and of the Queen Charlotte Islands, further North, are the unsubmerged portions of a sunken mountain range, which Dr. Dawson says may " properly be considered the bordering range of the Continent, as beyond it, after a sub-marine plateau of inconsiderable width, the bottom shelves very rapidly run down to the abyssal depths of the Pacific." This range is unsubmerged in Washington Territory.

From the romance of Geology as caused by the action of water, I turn next to the romance of Geology caused by the action of fire. I had been much puzzled in hearing of anthracite coal, ordinary bituminous coal and lignite being found within short distances of each other. I thought I knew that anthracite was characteristic of the more ancient rock formations, and lignite of the new. How was it that they were found so close together ? In turning again to the Geological Survey, I found the coal-bearing

formations of the N.W. and of British Columbia are of Cretaceous age, and when comparatively undisturbed, present the qualities of lignites, as in the valleys of the Bow and Belly rivers, near the Foot Hills of the Rockies. The lignite beds have been covered in this region with great sheets of boulder drift, and can only be seen where the rivers have cut deeply into their banks. But in the Rockies, the Paleozoic rocks have been thrown bodily on the top of the Cretaceous strata; the coal has been pressed and heated into true anthracite, and in some places it has been crushed and pulverised so as to be useless for practical purposes. Dr. Dawson says :—" The ancient crystalline rocks form no part of this district, which chiefly consists of Cambrian, Devonian, and Carboniferous strata, violently flexed, and often *completely overturned.* The Lower Cretaceous, which, previous to the great era of mountain elevation, had been at the surface, are completely folded in and crushed by the older rocks."

The Carboniferous strata of the Rockies contain, as before said, no coal, and bear evidence of having been " laid down in a deep ocean, far from land."

The mountain limestone affords the most beautiful scenery in British Columbia, of which the castellated rocks, called the Crow's Nest, the Beehive, the Chief, and Castle mountains, are the finest examples.

TABLE of the rocks near the South Kootanie Pass, which are representative of the entire region :—

Triassic and Permo-Triassic	H.	Fawn-coloured flaggy beds	100 feet.
	G.	Beds, chiefly red sandstone, ripple-marked	300 ,,
	F.	Magnesian limestone	200 ,,
	E.	Amygloidal trap	50—100 ,,
Carboniferous and Devonian Crinoidal limestone	D.	Compact bluish limestone. Forms some of the boldest peaks and crags of the mountains, and rests unconformably on Series C.	1000 ,,

Cambrian absolutely devoid of fossils	C.	Sand-stones and slaty rocks. Bands of bright red rocks	1000 feet.
	B.	Pale grey limestone, weathering white	200 ,,
	A.	Impure dolomites, and fine dolomitic quartzites	700 ,,

But the chief interest to me has been in the Cretaceous strata of the North-West Territory. All the great prairie country, comprising thousands of square miles, was once overflowed by the great Cretaceous sea, which must indeed have stretched to the extreme Western portion of the Continent, before the upheaval of the Rockies. In the North-West, as in the corresponding portion of the United States Territory, the rocks of Cretaceous age may be studied in perfection. In England, a great break occurs between the Cretaceous sea and the Eocene. This is supplied in the United States and N.W. Canada by that most interesting fresh-water formation, known as the Laramie. Of so transitional a nature are the fossils of the Laramie, that it was long known as the "Lignite Tertiary," and supposed to belong to the earliest Eocene. But near the Foot Hills, of the Rockies, the Laramie is found lying conformably upon the Fox Hills strata of the Cretaceous, and it is "often difficult to determine the exact point at which one is replaced by the other." "I have usually," says Mr. McConnell, "drawn the line of separation near the base of a thick band of greyish sandstone, containing no ammonites, baculites, or calcareous nodules, like those of the Fox Hills." The best exposures of the Laramie occur in the valley of the White Mud River, near the Cypress Hills, in the province of Assiniboia. This country lies so far from the mountains that its strata are hardly disturbed: some are horizontal, some with easy dips. All the plains are underlaid by Cretaceous rocks, seldom appearing at the surface, being concealed by a covering of drift, 200 feet thick.

The central plateau of the Cypress Hills is full of interest to the botanist. In the upper slopes of the hills, the vegetation is of the Rocky Mountain type, with plants of alpine and boreal, intermingled with prairie species, and in the deep valleys (known locally as *coulées*) are numerous *Eastern* forest species. In the more elevated regions, Lupins and Potentillas cover miles of country, growing eighteen inches high, and making the whole

country blue or yellow, or both. The grasses of the plateau are for the real pasturage species, growing so high, that Prof. Macoun* had great difficulty in forcing his way through them. No better summer pasture is to be found in all the wide North West.

The valley of the White Mud River is fully 600 feet deep, and its banks, more or less scarped, afford complete sections of all formations found in the hills. Small beds of carbonaceous shale occur throughout the section, often containing thin lignite seams. At the lower part, there is nearly always a band of nearly pure white clays and sands, bleached by the action of vegetable debris. This band, 20 to 15 feet thick, forms a conspicuous object up and down the valley, having the appearance of great snow-banks. Workable seams of lignite exist nearly everywhere at the base of the Laramie, but, as yet, no fossils of any kind, except silicified wood, have been found in this formation in Canada.

One of the most interesting of the Cretaceous coal-bearing regions is found on the Kananaskis River, in the Cascade Coal Basin of the Rocky Mountains. Its coal beds have been traced continuously for sixty-five miles to the Red Deer River, and are still found running to the North-westward, beyond that river to an undetermined distance. The Cretaceous rocks here form a long, narrow, synclinal fold, which, owing to the immense pressure from the South-westward, have been *bodily overturned* in the opposite direction, the mountain limestone being folded over them. This enormous pressure has converted the coal in the contained coal-beds into anthracite ; some of this is of excellent quality, but much has been so crushed and pulverised as to be useless.

At the Canadian Anthracite Coal Company's Shaft, there are seven seams of coal in a total thickness of 155 feet of measures. The lowest and most important seam is 4 feet 6 inches thick, and one hundred and thirty-five feet above this is a second, nearly 4 feet thick. This is a common feature of the Cretaceous coal beds of the North West and the Rockies, viz., the number of coal forests which must have grown and sunk whilst new forests grew upon their remains. In some places as many as eight coal seams, separated from one another by Carbonaceous shales and sandy

* Manitoba and the Great North-West.

clays, are found, and seven such seams are of common occurrence. Erect tree-trunks have sometimes been found.

Of the Tertiary formations, the Miocene stretches over an enormous area near the Foot Hills and in the Rockies. It covers an area of nearly 1,400 square miles, between the Cypress Hills, to the W., and the Swift Current Creek Plateau, to the E. The Miocene beds rest usually upon the Laramie, but sometimes upon the Pierre, always, however, unconformably. The Eocene seems to be completely missing in all parts of the vast region treated of in this paper, and the Pliocene is more or less doubtfully represented. It is *never found resting on the Miocene*, but always at much lower levels. The deposits of Pliocene age are known as the South Saskatchewan gravels. Hitherto they have appeared to be destitute of organic remains, but are known by their relative position to be intermediate in age between the Miocene and the Quaternary; in one or two places the admixture of Laurentian and quartzite pebbles towards the top show a gradual blending with the lowest glacial beds. They are, from their small extent and barrenness in organic remains, of small comparative interest.

The Miocene of the Rocky Mountains represents the "first renewal of sedimentation, after the great period of mountain making, and probably represents the deposits of ancient fresh-water lakes." In the Cypress Hills district, the Miocene consists chiefly of conglomerates made up of water-worn pebbles from the quartzite formations of the Rocky Mountains. The area now covered by the Cypress Hills has been changed from a depression in Miocene times, into its present position of the highest plateau of the plains, entirely by the arrest of denudation over its surface by the hard conglomerate beds which cover it. The conglomerate capping now overlooks, from a height of 2,000 feet, the lowest part of the plains. Valuable vertebrate remains have been obtained from these beds of extinct species of *Perisodactyla*, *Artiodactyla*, and *Rodentia*. One of the most interesting specimens belongs to the Creodont division of the primitive order of Bunotheria—*Hemipsalodon Grandis*, a powerful and dangerous carnivorous animal, with "a jaw more robust than that of any existing carnivore." *

* Professor Cope on the Vertebrata of the Cypress Hills.

On the whole, however, the results of the Geological Surveys of the N.W. are very disappointing to the paleontologist. Formations, which one thinks *ought* to contain most interesting and valuable forms, prove to be absolutely barren of fossils, contrasting painfully with the richness of the corresponding districts in the United States. The Cambrian strata, in the Rockies, have been searched for fossils, but without success; the Laramie is also barren; the Carboniferous rocks contain only invertebrate deep sea-forms; the Lower Cretaceous, with the exception of the Kootanie beds, is poor in organic remains; the Miocene contains but few remains of vertebrates, and these are in a very fragmentary condition. The lowest Cretaceous series, the Kootanie, has a rich and most interesting fossil flora. The plants "consist of ferns, cycads, and conifers, some of them identical with, or closely related to, those of the Jurassic of the Amur country, in Siberia, and others similarly related to the Lower Cretaceous of Greenland." No sudden break occurs here, but the Jurassic flora mingles insensibly with the Lowest Cretaceous, which here is partly, at least, a fresh-water formation. "Marine conditions," says Dr. Dawson, "appear in connection with parts of the Kootanie group, but it is evident that, while a great subsidence was in progress, sedimentation in general more than kept pace with it, leading to the frequent occurrence of tracts of land on which vegetation could flourish. This continued till the volcanic eruption occurred which produced the ash and agglomerate beds, after which, the sea held a prolonged sway over the region."

The following table will best show the position of the different Cretaceous beds in the Rockies :—

Laramie,	St. Mary River Beds	estuarine.
Cretaceous	Fox Hill and Pierre	salt water.
	Belly River Series,	
	Benton and Niobrara,	dark shales. 1,400 ft.
	Volcanic Rocks, greatest thickness	2,200 ft.
	Dakota and upper part of Kootanie	2,750 ft.
	Lower part of Kootanie	coal-bearing series, 7,000 ft.

In the Foot Hills and plains occur two higher beds of the Laramie :

The Willow Creek Beds ... 450 ft.
And Porcupine Hill Beds ... 2,500 ft.

I know of nothing in the story of our planet more strongly fitted to impress our imagination than the study of the changes which this part of the Continent of North America has undergone since the beginning of the Cretaceous epoch. The great Chalk age opens with land ever sinking, but still bright with island spaces, covered with exquisite tropical vegetation, cycads and ferns, sequoias, and magnolias. Luxuriant forests grow and are submerged ; the rapid sedimentation of the period fills up the shallow salt-water lakes, another forest appears upon the same site, and this process is repeated (through, who knows what countless thousands of years !) till the remains of seven or eight such forests are found one above the other. Then a period of violent volcanic eruption sets in, which could leave behind rocks 2,000 feet in thickness, but which could not move the Cambrian and Devonian strata from their deep graves beneath the earth ; this was to be done by a far more terrific convulsion.

Over this desolate plain of dust and ashes a wide sea rolls in, and stretches from the Great Lakes to the furthest limits of the Continent. Slowly again, after vast ages, the land rises ; fresh water lakes and marshes appear. Then commences another deep sea period, succeeded by the Laramie formations, where brackish and estuarine conditions prevailed. This slow and apparently peaceful rising of the land was followed by that tremendous outbreak of the central fires, which tore up the Cambrian and Devonian rocks from their abysmal depths in the bowels of the earth, and flung them fifteen thousand feet into the air. In mountainous masses the older rocks were hurled on the top of the Cretaceous, which for untold ages had accumulated peaceably above them.

The massive limestones were crushed, torn, contorted, flung about, as a child would fling hands full of sand, the strata in many places standing absolutely up on end. Then the scene changes to one of comparative calm ; the landscape is luxuriant with the beautiful semi-tropical Miocene flora, with its sequoias and cycads,

its sycamores, poplars, and oaks, and its curious fruit-beds.

Hardly less impressive than the flaming era of volcanoes and earthquakes; of torn and quaking rocks, which gave birth to the Rocky Mountains, is the contemplation of the remains of the Glacial Epoch. A vast pall of ice covered the whole width of the Continent; glaciers filled the mountain valleys to above the level of 5,000 feet. Great blocks of Laurentian and Huronian gneiss, utterly unknown as a formation in the N. West Territory, were conveyed a thousand miles and more across the plains to the very foot of the Rockies. Laurentian boulders are found on a high ridge, once itself a moraine, at an elevation of 5,280 feet within a few miles of the Paleozoic rocks of the mountains. The usual height at which these erratics are found varies between 4,000 and 4,600 feet; some are of enormous size, measuring 42 × 40 × 20 feet, and 40 × 30 × 22 feet. An enormous glacier, already spoken of, ploughed its way between Vancouver Island and the Mainland, and this was but one amongst thousands of others. Everywhere they have left their traces: in terraces, on the mountain sides, up to the height of 4,500 feet.; in drift deposits, to the depth of 200 feet over the prairies; and on the plains thickly strewn with Laurentian erratics.

The first great glacial epoch passed away, to be succeeded by another of less severity and duration, and with this we will end this "strange, eventful history."

Vancouver.

THE CHLOROPHYLL GRAINS IN LEMNA.—Stahl (*Bot. Zeit.*, 1880) states that in *Lemna trisulca*, the chlorophyll grains, which in ordinary diffused light are ranged upon the two walls of each cell lying parallel to the frond's surface, at night are driven to the side walls or lowest wall, leaving the superficial one bare. Mr. Spencer Le M. Moore (Journ. Bot., Dec., 1888), in his observations on the subject, differs somewhat from these conclusions. His results show that while many of the grains are driven by darkness from the superficial to the side walls, many of them still remain on the superficial wall. This subject of photolysis is a very interesting one, and observers having duck-weed convenient would find in it a profitable field of investigation.—*Bot. Gazette.*

Fresh-water Sponges.

By Henry Mills, Buffalo, N.Y.

THE fresh-water sponges have, within the last ten years, been brought into notice much more than in any decade since their existence was known. The simple manner of classification of Mr. Carter, of England, combined with the efforts of a few individuals, have brought this branch of natural history into prominence, equal to almost any subject within the range of microscopical research.

The first mention of the fresh-water sponges occurs as early as 1696, in the *Almagesticum Botanicum*, of Leonard Plukenet. Linneus also mentions them in 1745. These were both Botanists, and, like other Naturalists of that early day, considered all sponges, whether marine or of fresh-water origin, to belong to the vegetable kingdom. It was not till some advancement had been made toward the perfection of the microscope, that their character, in this respect, could be determined. They were several times changed from animal to vegetable, and back again. Ultimately, Grant, Carter, Bowerbank, Dujardin produced actual proof of their animal organisation. Subsequent investigators have verified their conclusions with regard to the fresh-water species. It was for a long time unknown what effect running, or still-water, had on their specific character. Those found in still-water were called *spongia lacustris*, and those found in running-water *spongia fluviatilis*. Subsequent observers, however, have learned that both species (the only two known at that time) grow indifferently in still and in running-water. In 1816, Lamarck introduced the term *Spongilla* for the fresh-water sponges; which term is now only used for one genus in Mr. Carter's classification, and, in that case, without reference to its etymological significance.

The vital organs of all sponges are supposed to be of the same character. They are too minute to be observed and defined, except by the most skilful observers, supplied with the best appliances, and under the most favourable conditions. Yet, the *flagellate infusoria*, which are the living factors of the sponge,

have been seen and sketched by many reliable investigators. For more extended remarks on this branch of the subject the student is recommended to the fifth chapter of W. Saville Kent's "Manual of the Infusoria," where the affinities of the sponges is fully discussed.

The skeletons of all the fresh-water sponges are made up of siliceous spicula, generally slightly curved, and pointed at both ends. These spicula are sometimes smooth, frequently slightly micro-spined, and, at times, roughly spined, varying in form and size in different species. Besides the skeleton spicula, in some species there are fine dermal spicula, which are mostly spined and finely pointed. In a few species, small and delicate birotulate dermal spicula are found in great abundance.

The great distinguishing feature between the fresh-water sponges and those of marine origin is the presence, in the former, of little seed-like bodies, large enough to be seen with the naked eye. These are a sort of winter egg, or resting spore, for the preservation of the species through the changes incident to fresh-water in winter. They have been called by various names, as gemmulæ, ovaria, and statoblasts. This last, by Mr. Carter (perhaps the greatest authority on the sponges), is in keeping with the name given to bodies of a similar character, found in the fresh-water polyzoa.

The walls of the statoblasts are made up of, and strengthened by, siliceous spicula of peculiar form. In some species they are birotulate, placed side by side, radially, in the wall of the statoblast. In other species they are small spined spicula, placed tangentially on and in the wall. In others, they are trumpet-shaped (*Tubella*), or shield-shaped (*parmula*). It is principally by the position and form of these minute spicula that genera and species are determined. But there are exceptions, as in the genus *Carterius* of Potts and Mills, where the foramenal opening of the seed-like body is prolonged, either by a tube, terminating in short cirrous processes, as in *C. tubisperma*, Mills, or by long tendril-like processes, as in *C. tenosperma*, Potts, and others of that genus. The generic name of one of the first known of the fresh-water sponges has been given in honour of Meyen, a German Spongologist, who, in 1839, first pointed out the use and position of the

birotulate spiculum in the wall of the statoblast. Hence we have *Meyenia fluviatilis*, *Meyenia plumosa*, and many others, the former of these standing, in a sense, as representative of the genus. The *birotulate* spicula resemble, somewhat, two car-wheels, with the uniting shaft in position ; the rotulæ being smooth, or dentate, or of other form in the different species. *Meyenia fluviatilis* is perhaps the most common of the sponges, and may be found in most rivers, ponds, and lakes. In my own experience, I find this and many other species most abundant in slowly running or in still but fresh water. They are found on the under sides of submerged logs, pieces of wood, and stones, as well as on weeds of different kinds. I have sometimes found them growing on the ground, where they were partly obscured by weeds. Darkness seems favourable to their growth, though not at all essential. The appearance of the fresh-water sponge, in some localities, and when mature, is not very different from that of our ordinary domestic sponge (which, in passing, is nothing more than the fibrous skeleton of a marine sponge). Sometimes they are green, and take on several hues, which I regard as of no specific value.

Sponges are found mature in October and November, at which time they will generally abound in statoblasts. Some species have an abundance of these as early as the latter part of June. They may then be found on the under-sides of stones, like a thin network, the statoblasts being very conspicuous.

In Mr. Carter's classification, the term *Spongilla* is used for his first genus, which includes many species, at the head of which stands *Spongilla lacustris*, one of the oldest of the sponges, and the representative of its genus. This is one of the most widely distributed, it having been found in America, from Nova Scotia to Vancouver's Island. Dr. Dybowski, of St. Petersburg, has found it in seventeen places in Russia, including the south-west of Lake Baikal, in Asia. I have found this sponge growing on stones in rather swiftly-running water. The water was shallow and rippling. The sponge was green, and might easily have been mistaken for an alga. On raising the stones, I found the sponge of a dull buff colour on the under-sides. Sponges of many kinds may be found by raking up the weeds from the bottom of sloughs, or ponds, or in any sluggish water, where they attach themselves to *Anacharis*,

Myriophillum, and *Utricularia*. But I have found them in very unlikely places, and in places where I was confident of success I was disappointed. After the student has found a few specimens, he will have no difficulty in identifying them, should they come in his way.

The mounting of fresh-water sponges is attended with as few difficulties as any other branch of microscopy; the chief one being to obtain the specimen perfectly transparent when mounted. To accomplish this, I take a small piece of the sponge, with a few statoblasts, and place it on a glass slip; then cover the sponge with pure *carbolic acid* in crystal, if in winter, warming it gently over a lamp. If in summer, most likely the acid will be fluid. If so, put a drop or two on the sponge, and let it stand for an hour, more or less, till it is quite clear. In a few minutes, however, it is likely to be clear enough to be able to determine the species under the microscope. If some of the statoblasts fail to yield to the clearing properties of the acid, they may be broken by pressure, or cut with a thin knife. They will then soon clear. The next process is to drain off the acid, and apply balsam and the cover-glass. If it is desired to mount many slides of the same species, a larger piece of sponge may be soaked in a watch-glass with acid for several days.

Some prefer to boil the sponge on the slide in a drop or two of strong nitric acid, repeating the process till the desired transparency is attained; but, as this acid does not unite with balsam, I can succeed much better with carbolic acid, which readily unites with it. For reducing thé sponge so as to leave nothing but the free spicula, it may be put into chlorinated soda, or water of Javelle, as it is sometimes called.

The spicula can then be mounted in the same manner as diatoms. For more extended remarks, the student is directed to the articles of Mr. Carter, published in *Annals* and *Mag. of Nat. History*, and to the monograph of Fresh-water Sponges, by Edward Potts, published by Society of Natural Sciences, Philadelphia.

Jan. 16th, 1889.

Spider Gossip.*

Part II.

How the Spider makes her Web.

By H. M. J. Underhill.

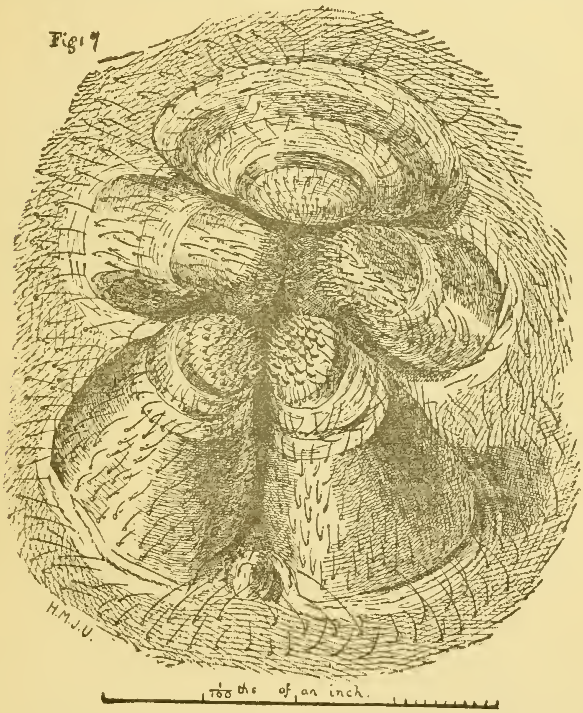
THE dusty cobwebs of unused rooms, the geometric snare of the garden spider, and perhaps the gossamer threads, which one finds in the fields on autumn mornings, are all the different kinds of webs usually recognised. There are many more, made by other kinds of spiders, quite as common, if not so conspicuous. Yet, in spite of the temptation to give a rapid general survey, I think it will be more interesting to restrict myself to one spider, the commonest, yet perhaps the most wonderful web-maker of them all, the common garden spider (*Epëira diadema*).

Any one who has watched this spider making its web will have noticed that the thread comes out of some little protuberances at the end of its tail. These are called "spinnerets." The word is a complete misnomer, for a spider's thread is not *spun* at all; on the contrary, it comes out quite straight, and is never twisted. But as the usage is so widely accepted, and since the idea of spiders "spinning" their webs is at least as old as Shakspere, one can only protest against the incorrectness, and employ the word oneself. Fig. 7 is a drawing of the so-called spinnerets of *Epëira apoclisa*, not the common garden spider, but one very like it. The uppermost part of the figure is the end of the spider's *cloaca*, which is drawn in section in Fig. 1 of my former paper.† Immediately beneath this organ is the upper pair of spinners; between them, much smaller, and darkly shaded, is the middle pair; and beneath these two pairs is the lower pair. The ends of these spinners are furnished with numerous small funnels or tubes, through which the silk is emitted in little threadlets. I call these funnels "discharge-tubes," and they may be better understood by a reference to Fig. 8. Those on the upper and middle spinners

* From *The Welcome*, by special permission.

† See *Journal of Microscopy*, January, 1889, p. 17.

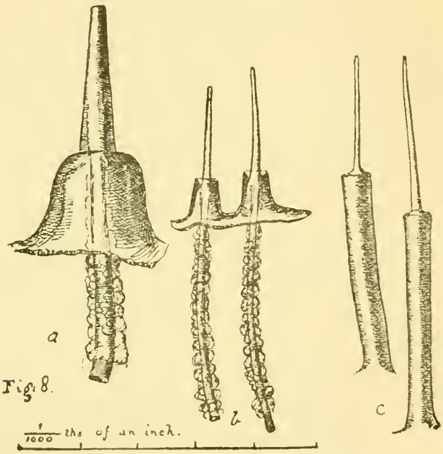
are of much the same shape (see *c.*); those of the lower pair, drawn at *b*, have a distinct form of their own. On all the spinners the arrangement of the discharge-tubes is such that they normally converge towards one point, so that the threadlets of silk, being semi-fluid, run together as they stream out. They harden immediately, and form, I am nearly sure, a solid, homo-



Spinnerets of *Epëira apoclisa*, magnified 55 diameters.

geneous thread. In his "Oceana," Mr. Froude gravely informs us that at the Melbourne Observatory is kept a certain refined breed of spiders which spin a thread of three strands only, instead of one of eight strands, as vulgar English spiders do. These three-stranded threads are unravelled by the skilful astronomers to get fine lines to measure with, because a whole thread is too

coarse. It is obviously easier, Mr. Froude says, to untwist a thread which only contains three strands, than one containing eight. True; but, since spiders' threads are not spun, nor made of twisted strands at all—what then? If Mr. Froude himself be not making fun, I think that some youthful and untidy astronomer must have invented the little fiction about the special breed of spiders to account for the condition of his unswept and cobwebby chamber.



Discharge-tubes from spinnerets of *Epëira diadema*: *a*, large tube from third pair of spinners; *b*, small tubes from the same, showing how the ducts from the glands terminate; *c*, small tubes from second pair of spinners. Magnified × 330 diameters.

The next question is, Where does the silk come from? In the section drawing, Fig. 1 of my last paper, is a general view of the silk-secreting organs, which are called "glands" or strainers, because they strain the elements of the silk from the surrounding fluids of the body. They are clusters of small bags, and the long muscles which move the spinnerets run down the abdomen through the midst of them. The glands are of different sizes and shapes, the most numerous sort being those which supply the upper and middle spinners. The glands, like the discharge-tubes of these two pairs of spinnerets, are very much alike; they are irregularly egg-shaped, and a small cluster of them is given in Fig. 9.

The ducts which connect them with the discharge-tubes are gathered into little bundles. Below these are the spindle-shaped glands which supply the lower spinners, and Fig. 10 is a section of one of them. It is, like all the other shapes, a little bag coated with layers of cells which have the property of absorbing the silk elements from the blood, and transferring them as liquid silk to the interior of the bag. Besides all these small glands the spider

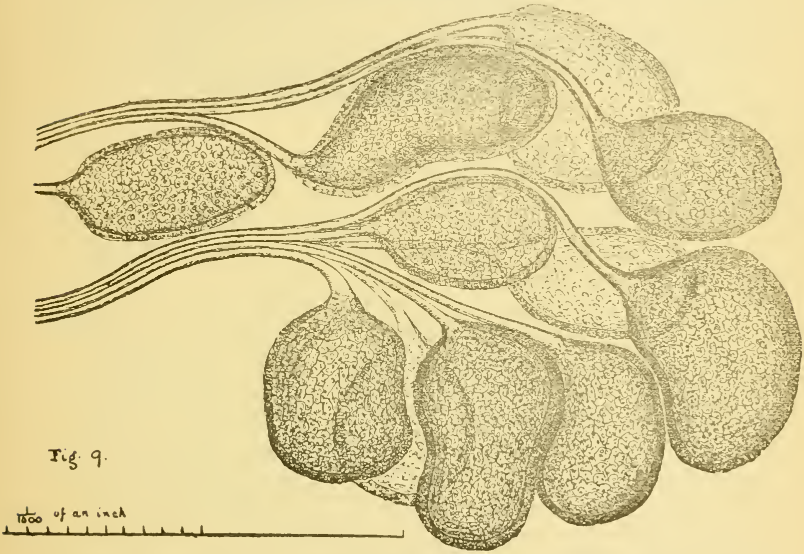


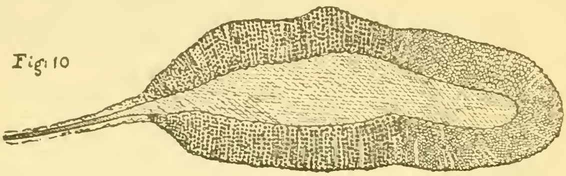
Fig. 9.

Group of silk glands of *Epëira diadema*, which serve the first or second pair of spinners. Magnified 110 diameters.

has about a dozen very large ones, similar in construction, which supply two or three very large discharge-tubes on each spinneret. Two of the large glands are shown in the former Fig. 1, below the ovary, which contains eggs. The position of the large discharge-tubes does not allow them to be clearly seen in the present Fig. 7, but one is drawn separately at *a*, Fig. 8. I conjecture that their use is to supply the sticky fluid of the web, *i.e.*, to glue each thread into a solid mass, to fasten it down to a leaf, etc., and perhaps to form the viscid globules (Fig. 12), which make a garden spider's web sticky. This is only guessing, and I have grave

doubts about their producing the viscid fluid, because a garden spider is the only spider that makes viscid globules, and the glands are present in all spiders that I have examined. But they are rather larger than usual in the garden spider, and I see no other apparatus for secreting the viscid fluid, besides these large glands.

Fig. 10



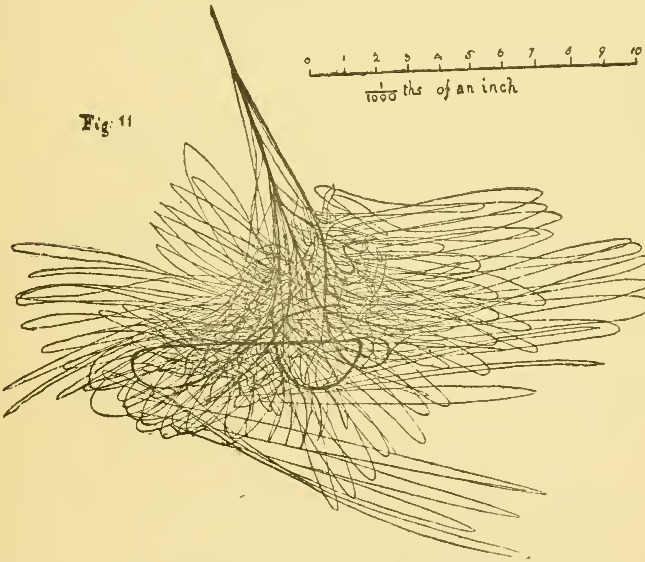
$\frac{1}{1000}$ ths of an inch.

Lengthwise section of gland of *Epëira diadema*, which serves the third pair of spinners, showing the inner bag which contains the silk in a fluid state, and its coating of cells which secrete the silk. Magnified 110 diameters.

Let us now accompany a garden spider throughout the whole process of making a web. It begins by "dabbing" its spinnerets on a leaf or twig and emitting a thread from the *upper pair*, spreading out for a moment the discharge-tubes, as one might spread the fingers of one's hand, or better, as a hedgehog erects its spines. The result is seen in Fig. 11. The threadlets, instead of coalescing into one solid thread, fall separately on the surface of the object, and, adhering immediately, get a broad, and therefore firm, hold. Fig. 11 is drawn from a "fastening" made by a spider on a piece of glass. It might be thought proof that a spider's thread is made up of fibres, like a piece of string. I think not; if it were so, the fibres could be distinguished with a lens of sufficiently high power, but an ordinary thread looks like a glass rod, when magnified a thousand diameters. Thick as the thread is compared with a threadlet, fifteen of the thickest in a spider's web can lie side by side in the space of one-thousandth of an inch.

Having made a fastening for a start, the spider walks away over leaves and twigs, trailing its thread behind until it gets far enough off, as it thinks—say about a foot in a direct line from the spot whence it started. Here it fastens the thread in a similar

fashion. Other threads are fixed in the same plane, so as to form a frame within which the geometric web is built. But garden spiders have another way of beginning. For reasons best known to themselves, they do not always care to walk a long way round. They prefer a short cut, which short cut, however, often turns out to be a long one. Some calm evening, when the air is without any breeze perceptible to our senses, a spider will get to the lee-side of a bush, and, walking out to the end of a projecting twig, will raise its abdomen and let out thread—not an ordinary solid thread—that would be too heavy—but something different.



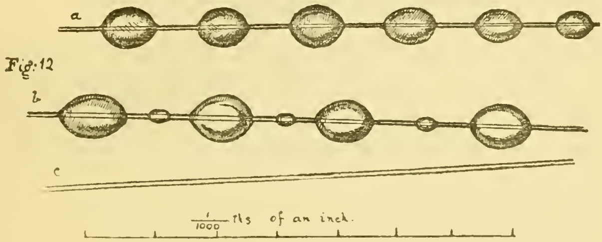
"Fastening" of a spider's thread. Magnified 170 diameters.

Instead of letting the discharge-tubes converge towards one point as usual, it spreads them, like it does when about to make a fastening, and thus it emits its many threadlets in a more or less separate condition. These are so very, very fine that they stream out on the wings of the tiniest zephyr. By-and-by, two or three will catch in the neighbouring twigs. Somehow the spider feels this, and, after hauling in the slack, fastens down her end of the

thread and trusts herself on the extremely fragile bridge thus formed. The distances crossed in this way are often very considerable, five or six yards being frequently measured, and the web in the middle of the space looks most curious. Having, in one way or the other, begun her operations and formed the frame, doubling or trebling its threads for strength's sake, the spider draws a thread across it, which is also doubled. Then it finds the middle of this, and fastening a thread there, from that point walks up to the top of the frame, always letting out thread as it goes. Going a little way along the frame, its fastens the loose thread to it, and returns to the centre by means of this new thread, which it doubles in the act of returning. This forms a second radius, and perhaps a third may be made in the same direction. But the fourth, at any rate, will be taken in the opposite direction, otherwise the centre piece would be pulled out of position by the strain of elastic threads all on one side of it. A fifth will be put across to another part of the frame, in order that the pull on the centre may be kept equal all around, and so the little animal goes on, until the number of the radii is complete. This number varies considerably. In a small web of *E. diadema* I have counted as few as twenty-five; in a web a little larger, forty-three; yet in an unusually large web with sixty-three rings to it, I found only thirty-two.

The radii are non-adhesive, and therefore cannot catch flies, so, as soon as they are finished, the spider proceeds to lay upon them a series of concentric "rings" (if one may call them so) of *sticky* thread. These "rings" are really all one endless thread, not complete circles, and they might be regarded as turns of an infinite curve, if the radii did not break them into angles. People suppose that a spider's sticky threads do not stick to the insect that makes them. This is quite a mistake. They adhere to a spider as closely as they do to a fly—if they happen to touch. So mark the wonderful instinct of the spider. The radii are too far apart at their extremities for the spider to step from one to another, but, by beginning at the centre of the web where the spaces between the radii are narrow, it goes round and round with its ring-thread easily enough, and, when the spaces get too broad to stride over, it uses the thread fixed the last time it came round,

as a bridge by which to cross the gaps. Now, if this thread were sticky, the insect could not do this, because, if it so much as stepped on it, it would either get entangled in it, or break it. What then is done? The ring-thread which the spider has spun, beginning at the centre and finishing at the circumference, is no more sticky than the radii, and equally useless for catching flies. It has, indeed, no such purpose, and is intended merely as a series of temporary "bridges" for crossing the inter-radial spaces, to enable the insect to fix its dangerous, sticky thread without risk of entanglement. It should be noted that its rings are much fewer and farther apart than the viscid rings. As soon as it is made, the spider begins again, this time not at the centre, but at some point in the circumference of the web, and lets out its sticky thread from the *lower* spinnerets, using, as I have said, the non-



Short lengths of web of *Epëira diadema.* *a b*, two ring-threads, with their viscid globules; *c*, one radius, non-adhesive. Magnified 375 diameters.

adhesive ring-thread as bridges for crossing the gaps between the radii. Each division is bitten off as soon as it has been thus used, for it is no longer wanted, and the presence of extra non-adhesive threads in the finished web would obviously impair its efficiency as a fly-trap. The sticky thread is fastened down to each radius by the hind feet, as fast as it streams from the spinners. It does not appear to stick at first, and the viscid fluid which coats it, and to which its adhesive power is due, does not run into drops for some moments. It is much more elastic than the radii, and two small pieces of it, with its drops, are drawn in Fig. 12. I do not think that the fluid is itself sticky—only viscid like glycerine; but drops naturally stick. Once this thread is fastened down, the

pider never touches it again, except when it goes on the web to catch a fly. Then the peculiar construction of its feet (see Fig. 13) enables it to hold on without getting entangled, yet the thread sticks so far that the spider is obliged to break nearly everyone it treads on, in order to get away. A few turns of the non-adhesive ring-thread are left round the centre of the web, and here the spider often sits. The centre is connected by a few strong threads with a shelter in some convenient corner, and here there is a "parlour" into which her ladyship can retire into private life. Let a fly but catch in the web, however, and the spider is down at the centre in an instant. It pulls the various radii to feel where the fly is (for it is very short-sighted apparently, and cannot turn its eyes), and rushes out across the web to secure its prey. If by

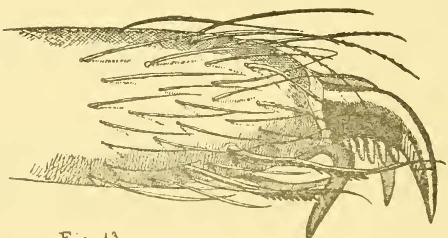


Fig: 13.

$\frac{1}{1000}$ths of in.

Foot of *Epëira diadema*, with its claws and toothed hairs. Magnified 75 diameters.

the time the spider reaches the spot, the fly has not got away (flies very often do get away), to see the spider wind it in a silken shroud is a sight marvellous to behold. A few turns with its feet, and the fly is covered all over. This is again the effect of spread discharge-tubes and separate threadlets, and it was by observing his process that I first found out that a spider could send out either one solid thread, or many threadlets, as it chose. Once in its shroud, the fly, like my story, is done. Dragging it up to its den, the spider sucks its blood till nothing but a dry skeleton is left.

Yet, thinking of the slaughtered fly, I have a few more remarks to make. I do not think that a garden spider's web is so

good a fly-trap as is generally supposed. A certain patch of ivy in our garden is literally covered with spiders' webs on warm afternoons. Yet here the bluebottles delight to fly in and out with just that triumphant hum which the nasty things always give when you try to catch them and don't. I firmly believe that they are playing a game of "catch'em who catch can." Very few get caught. "Zoon! zoon! zoon!" says a fly in a peculiarly vicious tone, and immediately there is a great hole in a web where a bluebottle has dashed right through. "Poor little fly," indeed! It is rather, "Poor little spider!" Only the careless get caught, and no self-respecting, well-conducted blowfly falls a victim, so that *Epëira diadema*, in spite of her elegant snare, has hard work to make a living.

THE SARRACENIA pitchers at Kew have begun to decay owing to the putrefying mass of insects they contain. In a note in the *Gardener's Chronicle* (Jan., 1888), Mr. Watson suggests that the secretion found in the pitchers is not necessary to the destruction of the insects caught in them, as the enormous mass of bluebottles caught in the pitchers at Kew could not have been effected by the few drops of the secretion contained in each pitcher. He also suggests that the pitchers, by entrapping such immense numbers of insects, collect "a powerful stimulant to the roots of the plants when, by the decay of the pitchers, the contents are deposited on the ground directly above where the roots find nourishment."

We learn from the *Botanical Gazette* (U.S.A.), that C. WARNSTORF, of Neuruppin, Germany, asks the directors of herbaria and all bryologists to aid him with material for study of the *Sphagnaceæ* of foreign countries. He promises to use submitted material with the utmost care, and unless otherwise specified by the sender, to return it after examination. He has in contemplation a *Sphagnologia Universa.* As C. Warnstorf is already known as one of the most thorough students of this perplexing group, we hope he will meet with a generous response to his request.

On some Common Species of the Gamasidæ

By Lieut.-Colonel L. Blathwayt, F.L.S.*

Plate IX.

I MUST offer a sort of apology for this paper, which is much less comprehensive than some months ago I had hoped to have made it. I fully expected to have been able to say something of the Gamasi in all their stages of egg, larva, nymph, and adult; but regret that it is only in the nymphal state that I as yet possess any knowledge of them.

Knowing that merely capturing and examining specimens would be of little use, I determined to try and keep the Gamasi in confinement so as to learn something, if possible, of their life-history. It would have been comparatively easy to have kept them in large glasses or jars with plenty of damp vegetable matter; but I could not then have examined them properly, and should have lost sight entirely of individual specimens.

On the 16th November, I caught a number of Gamasi belonging to three different species, on a *Geotrupes stercorarius*, and confined twenty-five in twelve small glass cells about half-an-inch in diameter. In the bottom of each cell I placed a piece of wet blotting-paper and a small piece of moss, besides which they had to be fed. Since that day—16th November—I have devoted about an hour daily to examining these creatures, and have kept a regular diary for each, except on three occasions, when I allowed a day to pass without attending to them, with the result that several died. One or two have been accidentally killed by the glass cover falling upon them when trying to escape; but thirteen are still alive and flourishing.

From what I could gather from writers who have treated of the Gamasi, I had good reason to believe that two months and a-half would be ample time for them to go through all their stages, die, and leave behind them a second generation; but in this I have been disappointed, for beyond growing fatter none have undergone any change whatever, and, except when crushed or dried up, none have died.

* Paper read before the Bath Microscopical Society February 5th, 1889.

The GAMASIDÆ form a family of the order *Acaridea*, class *Arachnida*, and are found sometimes on the ground in damp places, and sometimes parasitic on animals.

One of the commonest is that so often seen on beetles, particularly on those of the genus *Geotrupes*, though it attaches itself to Humble Bees and other insects. It was named by Linneus *Acarus coleoptratorum* (Fig. 1).

Of the Linnean genus *Acarus*, Latreille formed a family, the *Acaridiæ*, and divided it into five genera: *Trombidium*, *Erythræus*, *Gamasus*, *Oribata*, and *Acarus;* and of his third genus, *Gamasus*, he made *Coleoptratorum* the type.

Of these five genera, Dugès (1834) took one, Latreille's genus, *Gamasus*, and made this into a family, the *Gamasidæ*, which he again sub-divided into five genera: *Dermanyssus*, *Gamasus*, *Uropoda*, *Pteroptus*, and *Argas*. With only two of these genera, however—namely, *Gamasus* and *Uropoda*—I am now concerned.

Up to the last ten or a dozen years, great confusion existed in the classification of these two genera, which confusion is not as yet completely cleared up; for Dugès, Latreille, Degeer, and even Linneus, took for types of species, and occasionally even of genera, sometimes the males, sometimes the females, and sometimes the simple nymphs; and in 1876, M. Megnin published a paper to show that *Gamasus Coleoptratorum* of Latreille and of Dugès—the old *Acarus Coleoptratorum* of Linneus—was merely a nymph—that is, an individual imperfect and without sex; and that the division of the dorsal plate into two parts (*vide* Fig. 1), which had been taken as a special characteristic of the genus *Gamasus*, would disappear when the mite was full grown; that *G. crassipes* was the male * and *G. testudinarius* the female of the same species of which *G. Coleoptratorum* was the nymph.

I have a small beetle of, I think, the genus *Hister*, which one of my children caught in the garden and brought to me. It is so completely covered with these Gamasids that I could not determine its species without removing them, which I was unwilling to do. The beetle, although its body is almost hidden by the mass of parasites, does not appear to be any the worse for it, and runs

* Mr. A. D. Michael considers that in regard to *G. crassipes* M. Megnin is mistaken.

about, or I should say, "walks about"—for these beetles are very deliberate in all their movements—with as much ease as if its body was free; and this, I think, tends to show that Megnin is right in his belief that "the so-called parasites merely make use of their host as a means of transport from one place to another." If they really obtained their nourishment from the beetle, in the case in point the creature ought to have been half dead. Besides this, however, it is only through the membranous parts of the beetle that they could do so, for their mouth-organs, though powerful, could not pierce the hard, chitinous envelope, which in *Hister* will sometimes turn the point of a pin, and here they are crowded on head, thorax, and elytra as well as on the under-side of the body. Fig. 1 is a nymph of the old *G. Coleoptratorum* of Latreille, one of a large number (between forty and fifty) that I found on a *Geotrupes stercorarius*, all of which had the division of the dorsal plate, said by Megnin to be characteristic of the nymph.

These mites are blind—or, at all events, have no eyes—though it is quite possible they may be sensitive to light. They have two maxillæ, a pair of five-jointed maxillary palpi, and a pair of mandibles armed at the end with pincers like a lobster's claw. Fig. 2 is a sketch of the mandibles of a Gamasus. Those of *Uropoda* are somewhat similar, one difference, however, being that the mandible of *Uropoda* ends in a point, the fixed part of the claw extending far beyond the hinged joint; while in *Gamasus* they are nearly equal—a mentum, and a pair of seven-jointed labial palpi.

One interesting point about the members of this family is that they appear to form a link between the eight-legged *Arachnida* and the true insects, which have only six legs, for the details of their anatomy belong to both these classes.

In the true insects, the labial palpi are comparatively small, generally much smaller than the maxillary palpi. In the spiders, on the other hand, the labial palpi are very large; in fact, have developed into an extra pair of legs. But in the *Gamasidæ* and in the genus *Uropoda* this is shown very clearly; the labial palpi are midway between the two. They are greatly enlarged, many times bigger than the maxillary palpi, and to a superficial observation look like legs; but when carefully examined, are clearly seen

to form a portion of what would be the head, if the mite possessed such an article. They are, however, true feelers, and are never used as legs, the last joint ending in a long hair instead of claws, like the true legs.

In the genus *Gamasus*, however, these labial palpi, or first pair of legs (Fig. 3), end in claws and sucker like the rest—though they are used solely as feelers—and never for locomotion. When the creature is stationary, they are generally somewhat raised and bent backwards; but as soon as it moves, they commence waving backwards and forwards alternately. This species (*Gamasus Coleoptratorum*) run very swiftly, and although blind are remarkably clever at escaping when the glass cover of their cell is raised. The suckers at the end of their feet enable them to run quite easily on glass in any position, and it is evidently by this means that they can stick to the beetle even when it buries itself under ground. They seem sociably inclined, and I often see several collected in one corner of a cell, occasionally tapping one another with their long palpi. In *Uropoda* the mandibles and lesser palpi are retractile, and together with the maxillæ are generally hidden; but in *Gamasus* they are always protruded, and their maxillary palpi are constantly employed in brushing the mandibles. I have not yet seen this species in the act of feeding, but have several times watched the smaller kind with the undivided dorsal shield while so employed.

I will now go back to this *Gamasus* (Fig. 1), and it will simplify matters if I continue to call it by the old Linnean name of *Coleoptratorum*. It is, I believe, the nymphal stage of *Gamasus horticola* of Megnin, the *G. Fucorum* of Canestrini. I have had these under constant observation since the 16th of last November, and have endeavoured to find out, if possible, what their natural food is. Megnin says that it is from the liquid products of the decomposition of dead vegetable matter or the excrements of quadrupeds; and Kramer remarks that damp and decaying vegetation are necessary to their existence; and Dugès states that almost all Gamasids dry up and die in a few hours after being separated from the insect or stone on which they are found, unless they are kept in a damp vase; and Andrew Murray, in his work on the *Aptera* (South Kensington Museum Science Handbook),

says, evidently quoting Dugès, in reference to the family *Gamasidæ*:—"It is a peculiarity of all the parasites on insects, that they soon die after being removed from the insect or from the stone under which they have taken refuge, unless they are kept moist."

From my own experiments, I have found that it is the want of moisture alone which causes their speedy death, and that they will live for days on water only. One day in December, I picked up a *Geotrupes* half dead, that had upon it several Gamasids of different species, and laid it on its back in a small box. After three days, most of the smaller Gamasids were dead (the beetle being still alive), but the larger ones—those with the divided dorsal plate (*Coleoptratorum*)—were, to all appearance, quite well; but they had quitted their usual position between the fore-legs, and were congregated round the mouth, their mandibles and lesser palpi being quite hidden within it. This, I have no doubt, they did as being the only place where they could still find moisture. I then killed the beetle, and placed its head only, with the Gamasids still attached to it, in the box, and the next morning they were all dead.

On one or two occasions, I have allowed the cells to become rather dry, and in consequence several of the smaller mites have died; but *Coleoptratorum* seems less intolerant of dryness, and the only one of this species which I lost during the first two months I kept them confined was accidentally crushed. I make little doubt that the closely-allied species found on Humble Bees will prove to stand want of moisture still better.

I had not kept my Gamasids many days on vegetarian diet when I fortunately came across a paper by Mr. A. D. Michael, the author of a monograph on the British *Oribatidæ*, in which he mentioned having fed Gamasids on cheese-mites, and I tried the experiment with perfect success. I have several times seen the smaller species in the act of eating the cheese-mites. They suddenly darted out their mandibles and pierced the mite's body; the mandibles were then alternately withdrawn and protruded, turning from side to side within the body of the cheese-mite, like two spoons scooping out an egg; and in a few minutes there was little left but an empty skin. I believe they use the chelate ends

(Fig. 2) for cutting or tearing the inside of their prey; but I was not able to make this out satisfactorily, the mandibles being darted about with such rapidity. These smaller Gamasids made very free use of their pincers, and sometimes seized the hairs of a brush I used for moving them, and were rather difficult to dislodge; but *Coleoptratorum* has never done this. I have also seen one of the smaller ones seize a large one by its leg, and allow itself to be dragged several times round the cell before it would let go. *Coleoptratorum* I found to be very fond of gnats, and indeed seemed to prefer them to the cheese-mites; but they appear to have fed only by night (and, indeed, since I have kept them well supplied with food, I have not seen any, either large or small, in the act of feeding). They will not touch the ordinary house-fly, or any insect whose skin is at all hard; but small, soft larvæ were eaten during the night. I found, also, on *Geotrupes* several very small, soft-bodied mites, all of which were, however, underneath the wings of the beetle—the only place where they would be safe from the *Gamasi*. These I placed in the same cell with one or two of *Coleoptratorum*, and the next morning all that remained were their empty skins. I think it probable nocturnal feeding would be their habit in a free state, for it seems difficult to imagine a blind creature that does not form nets like the spider, or pitfalls like the ant-lion, being able to catch insects as the hunting-spiders do. But in total darkness the case would be different, for as they run with great rapidity, constantly waving about the first pair of legs, or labial palpi—which are thickly clothed with hairs, and evidently extremely sensitive—they would have no difficulty in capturing some of the smaller insects, such as *Poduræ*, which can be found at all seasons under stones, dead leaves, etc. It is also quite possible they may be guided to some extent by smell.

The Gamasids which attach themselves to Humble-Bees are extremely like the large species found on beetles; but still, present sufficient points of difference to be easily distinguishable. I am sorry I have not as yet kept any of these in confinement, as I commenced too late in the season, when the Humble-Bees were all dead, or at least very difficult to find, but I hope to be able to do so next summer.

Regarding the food of *Uropoda vegetans*, I have not yet been able to come to any conclusion. I have never seen them feeding, and they crawl about with extreme slowness. Hitherto, I have only found them when attached to various beetles, to *Porcellio scaber*, one of the wood-lice, and on two occasions—one of which is here shown (Fig. 7)—to the dorsal plate of a Gamasus. Their manner of attaching themselves is peculiar. The Gamasi (*Coleoptratorum*) can run with perfect ease over the smoothest glass, attaching themselves by the suckers at the end of the feet; in addition to which their very powerful chelate mandibles would enable them to grasp the hairs with which most insects are more or less provided, and even should their unwilling host shake them off, they are so extremely active that they could jump on again in an instant, and well merit the name of *Celeripes*, which was given by Montagu to the genus *Pteroptus*, and which deserves it far less.

The nymphs of *Uropoda*, on the other hand, are slow in all their movements, their legs being comparatively short, and generally kept doubled up and fitting into grooves on the under-side of the body, and their suckers seem less effective than those of *Gamasus*; the pincers at the end of their mandibles seem also less fitted for a firm grasp. Accordingly, they "drop anchor," so to speak, where they wish to remain. They exude, either from the anus itself or close to it, a whitish, transparent, gummy substance, which becomes quite hard, but retains its elasticity, and which forms a cord by which they remain firmly attached, as shown in Fig. 7. It was on account of this habit that De Geer gave them the name "*Uropoda*": οὐρα—a tail, πους—a foot; and "*vegetans*," because they seemed to grow like a flower on its peduncle, and because he believed that this cord was a tube through which the mite obtained nourishment from the insect to which it had attached itself, and he said that when they moved they detached the end of the cord from the beetle or other insect. In this, however, he was mistaken, as it is the end next the body of the parasite which is let go. On a specimen of *Porcellio scaber*,* I have several of the cords still remaining, from which the *Uropoda* have detached themselves. It was Dugès who first found out its

* This is, I think, a different species to that found on the beetle.

true nature, and he describes it as a horny filament, stiff and elastic when dry, and containing neither cavity, fibres, nor any organic structure. Firmly fixed to the body of the beetle by a sort of spreading base, and to the mite by a similar enlargement, which exactly covers its anus, he considered that it was not a silken cord spun by any special organs, but the viscous and dried excrement of the animal, and of which it can get rid whenever it makes a new excretion. The one which I kept alive was attached to the upper dorsal plate of *G. Coleoptratorum* when I found it on the 16th November, and it remained in this position without any sign of life until the 14th January (during which time it could have taken no nourishment), when I found it had disengaged itself and was walking about.

The mandibles of this creature are very peculiar, being as long as its entire body, within which they are generally retracted, their base lying just above the attachment of the cord, and they appear to have the power of darting out these mandibles to their full length (though I have never seen them do so), the long, sharply-pointed end of one of the claws—quite different to that of Gamasus—rendering it admirably fitted for use as a spear.

The smaller Gamasids—those without any division of the dorsal plate—were named by Dugès *Gamasus marginatus*, on account of the white membranous margin which shows round the edges of the dorsal shield, and which increases or diminishes in width, according as the creatures are more or less distended with food. Andrew Murray says of it:—"This species is also found on beetles more frequently even than the last (*Coleoptratorum*), and sometimes along with them; but, generally speaking, not more than one species of mite is found on the same beetle." In this, however, my experience differs from his, as I have always found it less abundant than *Coleoptratorum*, and invariably in their company, always finding two and generally three species of mite on the same beetle. Hermann, in his "Memoire Apterologique," reports that this species lives on dead bodies (for which reason he named it *Acarus cadaverinus*), and mentions that one was found running on the brain of a soldier who died in the Military Hospital at Strasburg, whose skull had been opened but a minute before. Hermann appears to have thought that the mite was

inside the man's head, but that, of course, is highly improbable. Canestrini, who a few years ago published a monograph on the Italian Gamasi, says that this is the nymph of another Gamasid—*Holotaspis marginatus*. He describes sixteen species of Gamasus and eight species of *Uropoda*.

It is now a generally-received opinion that all the Gamasids found attached to insects are either nymphs or young females. Mr. A. D. Michael, in a paper read before the Linnean Society, says that he caught the creatures while wandering about, and then bred them in confinement through several generations; and that those he bred were, in their nymphal state, precisely similar to those found on beetles. He does not, however, appear to have bred any from specimens actually caught on a beetle. On April the 14th, he found two nymphs wandering about, which he confined in a cell; on the 27th, both cast their skins, one turning out to be a male and the other a female. He kept them together, and on May 7th the latter laid eggs, which hatched about May 15th, and three days later the young larvæ turned to nymphs, and on May 27th again shed their skins and became adult. This allowed exactly one month for a generation, and I trusted I should have been able to confirm his experience; but hitherto I have been disappointed, for I have kept about twenty individuals for nearly three months (time enough for three generations) without any change whatever, except that in some the bodies became more distended, possibly from being stall-fed, so to speak, instead of having to hunt for their living, and some few died. But there was no further change—not even a change of skin. So I have been unable to give in this paper any account of either eggs, larvæ, males, or females. Mr. Michael was so certain that the nymphs he bred were identical with those found on beetles, that I can only suppose that I chose a bad time of year for my experiments, and should not have expected to rear large and prosperous families in the winter; for, according to Tennyson,

> "In the spring a fuller crimson comes upon the robin's breast;
> In the spring the wanton lapwing gets himself another crest;
> In the spring a livelier iris changes on the burnish'd dove;
> In the spring a young man's fancy lightly turns to thoughts of love."

And the above is probably true, even of the little blind Gamasus.

I. Blathwayt del. ad nat.

Gamasidæ

EXPLANATION OF PLATE IX.

Fig. 1.—Nymph of *Gamasus horticola*, Megnin (*Coleoptratorum*, Lat.), showing division of dorsal plate, × about 17 diam. *l.p.*, labial palpus (or first leg); *m.p.*, maxillary palpus.

,, 2.—Mandibles and Maxillæ of ditto seen from beneath, × about 90 diam. *m.*, mandible; *max.*, maxilla; *max.p.*, maxillary palpus.

,, 3.—Last joint of labial palpus of ditto, with claw and caruncle, × about 175 diam.

,, 4.—Last joint of labial palpus of *Uropoda* (found on *Porcellio scaber*), with small caruncle and no claw, × about 175 diam.

,, 5.—Last joint of labial palpus of nymph of a Gamasus, with entire dorsal shield, having neither claw nor caruncle, × about 175 diam.

,, 6.—End of hind leg of ditto, showing caruncle and large double claw, × about 175 diam.

,, 7.—Nymph of *Uropoda vegetans* (De Geer), attached to dorsal plate of a Gamasus, × about 90 diam.

,, 8.—First leg of *Uropoda* (from *Porcellio scaber*), showing how the legs are doubled up when the creature is at rest, × about 170 diam.

Sense of Direction in Insects.—Dr. H. C. McCook has observed a very accurate sense of direction displayed by the "horse-ant" (Formica rufa) of Great Britain, in laying out roads from the ant hills, to points in the surrounding woods. These roads or trails had in places a width of from two to four inches, and were distinctly marked upon the surface of the ground, which was stained a dark-brown or black, probably by the formic acid exuded from the insects, and the leaves and grass over which they ran was pressed down and smoothed by the constant passing of innumerable legs. From one large mound, three roads ran beneath the tall undergrowth, with remarkable directness to different oak-trees in which numerous aphides afforded a food-supply.

Road No. 1 was about sixty-five feet in length, and ran in an almost perfectly straight line. No. 2 was about seventy feet long, and varied less than three inches from a direct line measuring from the tree to a point within two feet of the terminal tree. There the trail made a detour of about six inches. No. 3 was a little over one hundred feet in length. A short distance from the nest, it touched an old stump which deflected the path at a slight angle, and further on it crossed a foot-path where the trail of the ants was much interfered with by passing human feet. In spite of the difficulties of the track, when the entire trail was staked off, its terminus was found to deviate less than three feet from a straight line drawn from the point of departure.

Microscopical Imagery.

By Dr. Royston-Pigott, M.A., F.R.S.

Solar Splendours.

Plate X.

TO obtain heliostatic diffractions of the highest order, an exceedingly small beam of light must be attained from a distant luminous source. (See "Circular Solar Spectra, Proceedings of Royal Society.")

In some cases, eye pieces were placed to catch the solar beam, also objectives. Plane mirrors, silvered at the back, utterly failed. I was therefore driven to depend upon the truth of the surface of the prism, acting by internal reflection. To show the exceeding delicacy of the experiments : If two plano convex lenses are placed with coincident axes on the stage, a good many coloured rings can be seen, but no black ones. So soon as their axes become in the least degree oblique, the solar spectrum takes an intricate form, whilst the centre shows a brilliant black Maltese cross. Very worthy of the highest photographic art, are all the rich forms displayed.

Supposing only one plano convex lens is used, the most striking appearance, amid such splendid effulgence, is a very thin, intensely jet black ring enveloping the small brilliant central disc. The rings change their appearance every instant with the most minute alteration of the focal planes.

On first viewing this amazing glory, my attention was arrested by the shape of the primary black ring being squared off. Upon severe examination, I found it was composed of several excentric rings, which no change of collar corrections or length of body at all ameliorated. Another fact rather surprised me : "collar adjustment" entirely, in some glasses, decentred the solar disc, so that two discs appeared occasionally instead of one—the sign of inferior workmanship. (See Plate X., Fig. 4.)

An Andrew Ross "quarter" (1851), displayed several irregularly placed central discs, which formed so many different centres of diffraction rings. A Berlin glass (Gundlach) showed a much finer primary black ring ; but in a deeper focus I saw four spurious

discs. A one-sixteenth water immersion of Powell and Lealand, displayed two overlapping spurious discs, each forming its own independent diffraction-systems above the best focus and evanishing below it with a confused bright halo.

It seems extraordinary that a simple plano convex lens, forming the miniature of the sun, emitting a very minute beam, should be capable of testing severely the qualities of observing objectives.

A very excellent water immersion, one-tenth, was armed with a small piece of thin glass attached by water to the front lens, and focussed upon the spectrum. Deepening the focus with exceeding lightness of touch, the central disc became snowy or pearly white, set off prettily by its companion black ring and a number of pale lavender, pale rose colour, and then brillant outer circles of bright green with intervals of orange-red, and more outwardly still circles of red merging into ill-defined black. By this diffracting solar pencil, the precision of the construction of this fine glass was thus revealed by the use of a simple convex lens of crown glass of half-an-inch focus.*

As the axis of this single lens was necessarily unique, the phenomena, especially the sharpness and intensity of the jet black ring, could only be so superbly exhibited by very fine glasses. Inferior glasses blurred them, and utterly marred the rich and delicate beauty of the colours. Contrasting a variety of English and foreign glasses, many appearances arose, which indicated grave errors of construction, too numerous for insertion here. The secret for accomplishing these most extraordinary glories, is once for all the employment of a very minute beam of solar light, emanating from a small orifice as aforesaid, a few yards distant. In the focus of a powerful microscope,† brilliant coloured rings were developed by a half-inch convex plane lens. Upon examining the axis in different focal planes of vision (*i.e.*, different sections of the conical solar pencil), I counted no less than 48 magnificent rings, including black rings and interspaces, at one time in the same field of view (Fig. 3). Derived directly from the sun, with the brilliance belonging to total internal reflection, this rich assemblage

* The eye-lens of a Huyghenian eye-piece.

† Sir G. Airy informed me he had seen a few of these with a pocket lens.

of gorgeous rings, rivalling each other in prismatic splendour, set off by the sharp contrasts of jet black, well-defined borders, and shaded with the most delicate tints, melting into one another with an exquisite softness, reminded me of the eloquent and glowing language of Sir John Herschell, when describing the phenomenon of diffraction. Doubtless these appearances, emanating from the solar orb, surpassed in intensity and brilliance those he examined. Careful measurements gave the thickness of each coloured ring to be 1-16,000th,* the same as that of the central disc, whilst its black-ring-setting was 1-50,000th thick.

To subdue the intolerable brightness of the miniature sun, displayed on the microscopic stage, which was almost blinding in brilliance, deeper eye pieces and a lengthened tube were employed, till the whole field of views was entirely embraced by these magnificent appearances. The observing objective was constructed for a water film ; upon fixing a drop to the front, and securing it with a fragment of cover glass, three-thousandths of an inch thick, I was rewarded with the apparition of a solar disc, perfectly circular, surrounded by a truly circular black ring (Figure 4). Each of these splendid rings appeared of exactly the same breadth under 1,000 diameters.

The circular solar spectra formed by this ½-inch plano convex lens, viewed with a high quality immersion system, were thus arranged, from the centre outwards :—

Coloured Rings.	*Intervals.*
Ring I.—Solar disc, white ...	Primary ring, jet black.
,, II.—Pale lavender ...	Secondary ring, black.
,, IV.—Lavender	Third ring, ,,
,, VI.— ,, ...	Fourth ring, ,,
,, VIII.— ,, ...	Fifth ring, ,,
,, X.—Pale rose	Sixth ring, dark red.
,, XII.—Bright green ...	Seventh ring, ,,
,, XIV.— ,, ...	Eighth ring, ,,
,, XVI.— ,, ...	Ninth ring, ,,
,, XVIII.— ,, ...	Tenth ring, black
,, XX.—Orange	Eleventh ring, ,,
,, XXII.—Deep orange ...	Twelfth ring, ,,
,, XXIV.— ,,	

* Really 16⅔ thousandths.

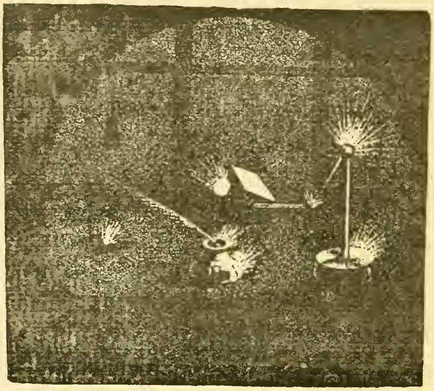
A deeper focus showed a deep blue central haze, melting with a fine red fringe (*Circular Solar Spectra*, *Proceedings R. S.*, *No. 146*).

In precisely the same way the spherules of diatoms develop a great variety of interesting phenomena, under solar illumination especially. Here is an extract from my note-book, which fairly describes solar phenomena, seen in that exquisite diatom, *Aulacodiscur Comberi*:—"The sun shines. The frustule is glorious with solar spectra. No condenser. Size of smallest visible disc 1-75,000th (inch), of largest handsomely shown, 1-20,000th. The solar spectra are of a noble order of beauty and precision. A few diffraction rings are vividly seen, but they are all more or less broken by another lower stratum of minute beading. The smallest brilliant disc is surrounded by a perfectly formed circular black ring, about the 200,000th of an inch thick. A dot appears either above or below the disc according, as the observing objective is, in a slight degree, positively or neg?tively corrected by its screw collar. I shall now venture to describe one of the most startling observations it has been my good fortune to witness :—

On a sunny day, an iris diaphragm by Beck, capable of closing up to 1-100th of an inch, having been screwed into the nose of the microscope, a very fine one-sixteenth objective, made expressly by Powell and Lealand, was directed to examine *P. Formosum* by transmitted sunbeams. This diatom was chosen as its spherical beads were nearly the same size as the heliostatic image of the sun, 1-40,000th. Now according to optical theory, each spherule should emit pencils of many coloured rays ; in fact, a complete spectrum. Now for the result : on closing up nearly the iris, so as to reduce the objective aperture to 1–100th of an inch, solar rays being obliquely employed, I was amazed to see a brilliant isolated disc glow forth with an intense coloured effulgence, and still more was I astonished to see each spherule successively glowed with a differently coloured effect, when the slightest change was made in the obliquity of the illumination. But the instant the iris diaphragm was opened, all this solar glory utterly vanished. The experiment is significant, though very difficult of attainment. (Read before the Royal Society.)

In carrying out for some years researches on circular solar

spectra, I found silvered mirrors useless, but the internal reflections of a distant prism fully succeeded. The illuminated prism heliostat, is roughly delineated in the engraving, and when seen, has been mistaken for the electric light.



The aerial solar image, 100 inches distant, formed by the prism armed with a 3-inch lens, was 1-40th of an inch in diameter. A small plano convex lens placed truly on the "stage," now further reduces the image and dims the effulgence. On focussing with 1000 diameters upon the solar miniature, cruel revelations are instantly made. Imperfect curvatures and centering of the observing objectives are at once made manifest. These errors are egregiously displayed. The central rings are irregular in outline, confused, and excentric. (Figs. 5, 6, and 7.)

(To be continued.)

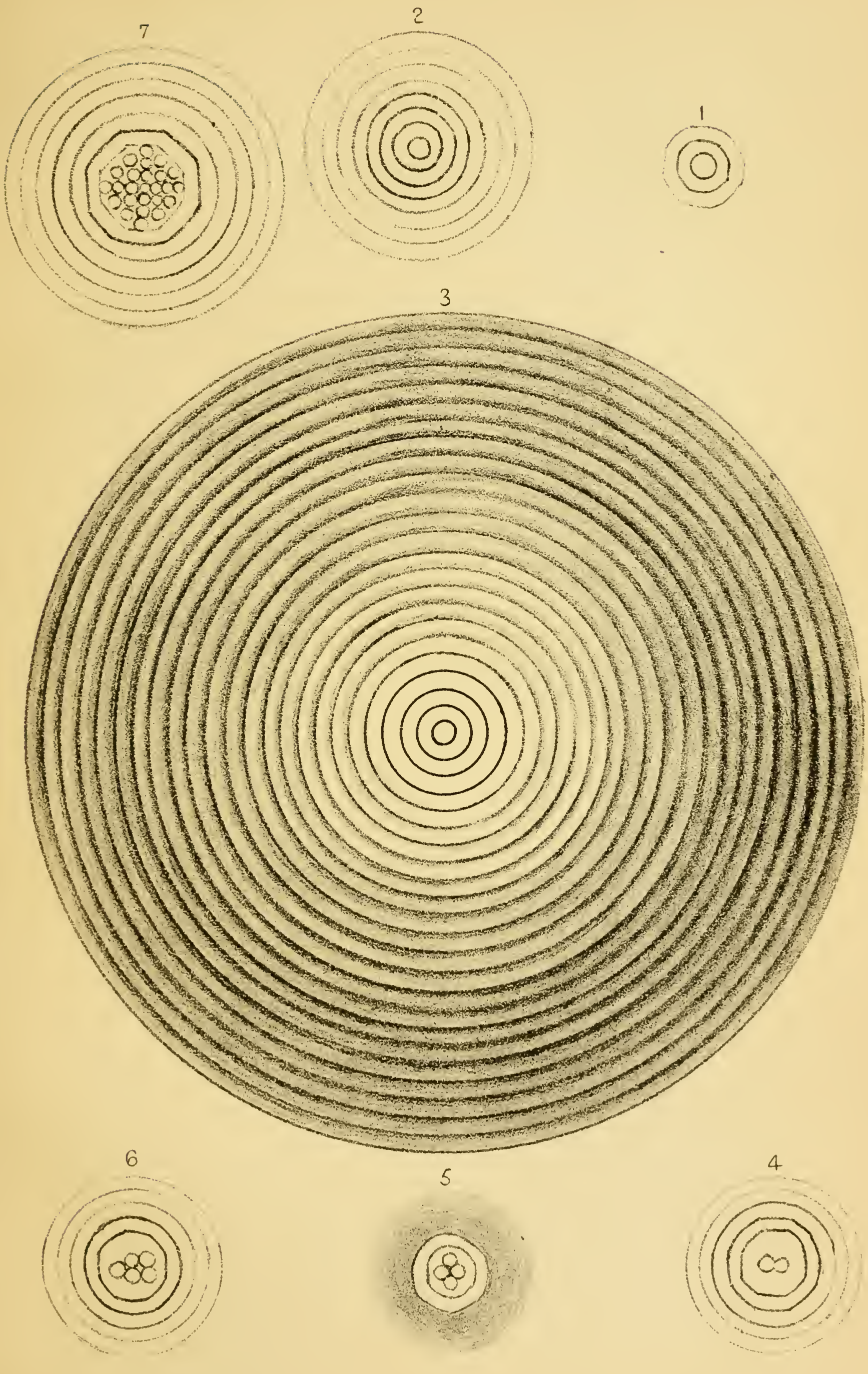
EXPLANATION OF PLATE X.

Fig. 1.—Primary rings finely defined at the first visible focal plane.

,, 2.—Secondary rings at a deeper focus. The central discs should have been squared off.

,, 3.—Exhibition of the greatest display of rings, each annulus having its own breadth equal to that of the central disc, which is brilliant white; the succeeding, lavender, rose colour and red rings, separated by dark rings, the first few of which are jet black.

,, 4, 5, 6, 7.—Development of two discs instead of one; also of four irregular discs showing the existence of displaced centres and irregular diffractions.



Microscopical Imagery.

The Development of the Tadpole.

By J. W. Gatehouse, F.I.C.

Part VI. Plates XI and XII.

As in human affairs it is proverbially unsafe to predict what may occur on the morrow, so I find, on referring to the last article, it would have been much safer not to have hazarded an opinion on the possibilities of development in tadpole life which might occur in the same limited period. There it was suggested as improbable that teeth could possibly be elaborated, and grow from positive nothingness into a condition fit for use within two days, and although the event has not absolutely falsified the prediction yet, so rapidly were tadpole teeth developed that, whereas on March 30th there was no sign of a tooth either within or without the mouth cavity, yet on April 5th numerous papillæ—dark, triangular, and pointed—were standing up in many ranks, only requiring to be hardened in order to become useful in feeding. Indeed, it would be difficult to conceive a more wonderful series of changes to occur in the development of an animal whose life-history is by no means an ephemeral one than actually took place in the growth of these creatures between March 29th and April 7th.

At the former date the mouth was a simple tube terminating in a blind sac, although perforating the body as far as the region of the heart and lungs, there being no direct connection between it and the proctodeum through an alimentary canal. At the later date (April 7th) the alimentary canal extended from mouth to tail, consisting of a perfectly perforated tube, armed at the mouth with a by no means despicable means of seizing and tearing food.

It is the object of the present paper to attempt a description of some of the changes by which so profound an alteration was brought about. Referring back to the diagrams accompanying Parts 3 and 4 of this article (July and October, 1888), it will be noticed that the greater part of the posterior portion of the body is still filled with undifferentiated yelk-mass. The alimentary canal may thus be seen to consist of three distinct portions—

distinct not merely in position, but also in the time and manner of development.

Thus the stomodeum, or mouth, and the proctodeum, or anus, are both formed at a very early period, and lined with epiblast, which gradually thickens, till under a low power it appears as a very thick dark line. Certain involutions and almost invaginations occur in the straight tube forming the mouth, which renders it better suited as a prehensile organ. On March 29th and 30th the lips are of a very simple and primitive character, the upper lip being able to close over the under in an apparently close and perfect grasp. But at this period it is well to remember that unless the food were digested in the mouth cavity itself, it would have been perfectly useless for the animal to have eaten, as none of the products of digestion could possibly have found their way by the usual channel through the body. From observations made on the living creatures, I am, however, of opinion that the animals at this period did actually take some kind of material into their mouths, as stated in the last paper; but if so, any undigested matter must have found its exit by the same way in which it entered, thus showing a slight resemblance to the Cœlenterata in the mode of obtaining nourishment.

This process, however, continues only for a very short period, and although, of course, we cannot state that every animal dissected on the same day is precisely in a similar phase of development, yet from the number of dissections made and the general similarity of the appearances found in all the sections taken from various animals on the same day, it is certain that not more than two days, and probably in many cases much less than this time, elapses from the instant the creatures open their mouths, and thus necessarily fill this portion of the alimentary canal with water to the period when the middle portion of the canal, or true stomach and intestines, are fully formed so as to exhibit their spiral formation.

Directing our attention to the mouth only, we find that the upper lip first becomes somewhat indented, the outer portion of the indentation growing into a very delicate prehensile organ, furnished at the extreme edge with a number of minute teeth or bristles with recurved points, so small as to require fairly good

magnifying power to see them. This ridge, with its crenated edge furnished with these little bristles, extends entirely around the mouth, the sides, however, being quite free from bristles, but instead it is there worked up into a series of small, digit-like processes, apparently extremely soft and delicate.

The fleshy fringe thus surrounding the mouth proper is much longer on the under than on the upper side, and apparently capable of a certain amount of extension, so as with the upper portion to form very effective lips, inside which are the true teeth. These are formed from the epidermis, which rapidly hardens, and as the intestine is forming farther back in the body, these are developing on what was a short time previously the inner portion of the lips.

The teeth in the upper jaw are arranged in a series of points behind each other, and in the lower, they take the form of a number of parallel serrations. A diagram of the upper rows is given in Plate XII., Fig. 7, and an enlarged diagram of the mouth in Fig. 6 of the same plate. Immediately behind the lower teeth inside the mouth there is at this period a decided protuberance, or pad, furnished at its very tip with a small projecting point, and on the upper portion of the palate an invagination of the epidermis occurs, filled with granular matter. This invagination is the internal opening of the nasal organ, which stretches from the mouth upwards into close proximity with the fore-brain, and then bending round at approximately a right angle opens again on the outside above the mouth, forming the external nostrils. The granular matter with which the cavity is filled has, for the most part, no definite shape ; but near the internal opening it presents, in some cases, the appearance of round, nucleated cells, with two delicate extensions proceeding from each of them. The wall of the cavity consists of square nucleated cells, packed closely together, arranged generally in a single row, but for a portion of the boundary it appears as a double row. At the internal opening of the cavity is a small protuberance, formed by a projection of the lower edge of the epithelial layer, and the whole orifice is nearly closed by a pear-shaped organ, abruptly pointed on the anterior, and connected behind only with the true roof of the mouth-cavity.

From the relative positions of these two structures, it would appear that the smaller protuberance prevented the actual closure of the internal nares by the larger, there being always a small channel left just at the blunt apex of the latter. In another section, the larger of these two bodies lies so distinctly behind the aperture that it could not have covered it, the blunt tip barely reaching the posterior border of the canal. The granular matter lying near the external opening is distinctly arranged in the form of a number of rods lying closely packed together.

This, although the largest, is by no means the only invagination in the upper portion of the mouth. Each invagination is connected with a minute protuberance on the surface of the palate by means of delicate canals. From an examination of some of these protuberances and slight invaginations, where the process has apparently only just commenced, it would appear as though the epidermis split into two parts, one becoming invaginated and the other raising itself into a slight knob, the latter being decidedly noticeable, whilst there is still scarcely any trace of the former. If these, as I have every reason for believing, be really glandular structures, it would indicate that the external duct is formed rather before the internal gland.

Immediately behind the pad previously mentioned, there is a raised portion of the epidermis on the lower jaw, looking exactly like a small papilla ; but as it stretches backward to a considerable extent along the floor of the mouth, I believe this must represent the first formation of the tongue, and especially as no other trace of this organ can be discovered. If I am correct in this suggestion, the tongue also arises from the epidermal layers, not by an invagination, but by the opposite process of an outgrowth of the epidermis, the lines producing this outgrowth being most distinctly visible in a section of April 1st, which, however, I believe to be somewhat more advanced in development than the average of that day. The only structure I can make out in this protuberance with a $\frac{1}{4}$-inch object-glass is that of almost flattened papillæ or slight prominences covering the raised layer.

In Plate XI., Figs. 1 to 4, will be found diagrams, in which rough attempts have been made to delineate some of the many

changes whereby the undifferentiated yelk-mass is converted into a spiral intestine. It must be remembered that this yelk-mass, after the formation of the viscera (already mentioned in the previous articles), consists of an egg-shaped mass, the larger end being towards the front and the smaller somewhat elongated end behind. Through this smaller end the anal portion of the canal extends, well marked by dark cells arranged close together in two parallel rows, leaving a space between them. The first alteration appears to take place in the upper portion of the broad anterior end, which becomes indented and gradually turned round, so as to form a kind of crook, whose cells arrange themselves in parallel rows, leaving a mass of less-altered cell-tissue between them, thus producing a resemblance to a closed tube. Next, or almost simultaneously, the yelk-mass breaks up into two portions, each surrounded by its own delicate membrane. From the upper mass, the greater portion of the coiled intestine is formed, whilst the lower is converted into the bladder. This conversion of a mass of cells into a tube takes place by certain cells parting slightly from each other, and their inner edges becoming thicker, blacker, and more dense, thus forming the rudiments of a tube. It is at the front portion of the yelk that the tubular structure is first seen, and as these portions become separated from each other they are enveloped with a very delicate skin, which ultimately forms the mesentery, and holds the whole of the spiral canal in place. The bladder, at one period of its history, appears as a hollow mass of cells bounded by conical masses, with their apices pointing inwards.

After the indentation and marking-off of the anterior portion of the yelk-mass, the lower part also becomes tubular, so as to attain a form somewhat like that shown in Plate XI., Figs. 1*a*, 1*b*, 1*c*. From this point, it is almost impossible to follow the exact stages whereby this mass becomes formed into a spiral. The proctodeum, however, is soon connected with the inner coil, and it only appears to be towards the last stage of the process that the mouth becomes attached and a perfect tube is thus formed. Some of the stages are shown in Plate XI., Figs. 2, 3, and 4, and the perfectly coiled tube in Plate XII., Fig. 5, where the coil apparently takes up the whole of the lower portion of the abdo-

men, to the exclusion of every other structure. It must be remembered that this is more apparent than real, and only applies to the particular section drawn, as, of course, the bladder finds a place somewhere within the cavity, although not shown in this diagram. The tail also stretches far beyond the limits of the plate. This spirally-coiled intestine is of the most simple structure, consisting, for the most part, of a single row of rounded cells, some of which, however, have in places begun to flatten and form rough parallelograms, whilst others are distinctly pointed instead of rounded on the outside.

Unless these minute differences in form are indications thereof, there are no signs of the villi which at a later stage line portions of this tube, and especially in the adult state, when the tadpole has become a frog, and the fish has been converted into the amphibian. No wonder that the horny cases of the *Glochidia*, mentioned in a previous article, disagreed with the delicate digestive powers of these little creatures!!

At the same time that these changes were progressing in the abdominal regions, others not less great and interesting were taking place in the region of the gills and lungs. The right gill atrophies before the left, both ultimately becoming covered by the opercular membrane; but for some days after the right gill has been quite enclosed, water finds its way into the left side through a small opening to bathe the internal branchiæ, which now exclusively carry on the work of respiration.

These internal branchiæ are situated in branchial chambers, whose walls are largely composed of cartilage, to which the branchiæ are attached. The branchiæ are in rows, the outermost ones terminating in long tufts. The median tufts are not so long, but each ridge is furnished with a blood-vessel running around its inside edge, and by means of which the blood it contains is exposed to a large surface of fresh oxygenated water for aeration. Whitney, in the "Royal Microscopical Society's Transactions, 1867," p. 43, gives a lucid account of his experiments on the living tadpole, by which he was able to demonstrate the connection between these and the true lungs. He there states that three arterial trunks arise from the heart, and convey the blood to the outer gills whilst the inner are forming, but at the same time

Development of the Tadpole.

are also connected with the immature inner gills, and as these grow and take more of the blood proceeding from the heart, so the outer ones receive less, and thus atrophy in consequence of the comparatively less amount of nourishment supplied. These inner gills, he says, are functionally active, almost to the very end of tadpolian life, when, from a less amount of blood traversing the gill-crests, and a greater quantity being forced into the cephalic and pulmonary arteries, they lose their form, gradually shrink, and give place to true lungs.

This is, however, at a much more advanced period than that to which we have now attained, and must be left for another paper.

EXPLANATION OF PLATES XI. AND XII.

Plate XI.

Figs. 1, 2, 3, and 4.—Different phases in the development of the tadpole, showing vertical sections of March 29th, 30th, 31st, and April 1st, to illustrate some of the changes which occur during the passage of the undeveloped yelk into the coiled intestine, and also of the simple mouth without teeth into the fringed mouth containing several rows of teeth.

1 *a.*, 1 *b.*, 1 *c.* Phases in the development of the undifferentiated yelk with the coiled intestine.

Plate XII.

Fig. 5.—Tadpole of April 5th, showing coiled intestine, fringed mouth, muscles of the lower lip, and internal gills.

,, 6.—Mouth on larger scale, showing hooked bristles and rows of teeth.

,, 7.—Teeth, × 240 diameters from upper jaw.

,, 8.—Enlarged crests of the inner gill, showing the blood-vessels passing around each crest, as well as the more elongated crests at the edge of the gill. *ms.l.*, muscles of lip ; *oc.*, eye ; *ms.no.*, muscles of notochord ; *lp.*, lip ; *h.*, heart ; *l.*, liver ; *yk.*, undifferentiated yelk ; *p.r.d.*, pro-renal ducts ; *n.*, notochord ; *i.n.*, internal nares ; *m.c.*, termination of mouth-cavity ; *i.*, intestine ; *bl.*, bladder ; *f.b.*, fore-brain ; *no.*, notochord ; *t.*, teeth ; *m.*, mouth.

Answers to Queries.

1.—**Sealing Bottles.**—It is no use trying to keep spirit in corked bottles; whatever you use, it will inevitably get out some way. You must get wide-mouthed bottles with glass stoppers, which can be obtained at any large chemist's. For temporary purposes, a well-fitting cap of lead paper, squeezed tight round the neck of the bottle, is better than cork, or cork may be supplemented by this. X. Y. Z.

4.—**Rotifers.**—Yes, you may guess that from habitat. See *Encl. Brit.*, 9th ed., article *Rotifers*:—"A few species will appear in countless numbers in infusions of leaves, etc., but their appearance is generally delayed until the putrefaction is nearly over. Species of *Rotifer* and *Philodina* appear in this way." This delay in their appearance probably means, that they feed on the remains of the dead bacteria, etc., which have taken an active part in the process of putrefaction. B. LINDSAY,

Examiner in Zoology to the *Cambridge Examiner*.

5.—**Four-footed Bird.**—I cannot find any further notice of the *Opisthocoma cristata*, but will try to procure the original memoir. The discovery is, however, not very startling, when the paragraph you allude to is carefully read. The bird is not "four-footed" when adult. The limb of the adult form loses its claws and becomes an ordinary wing, as you may easily suppose from the plan given to the type in classification. (See the best and newest English Manual of Zoology, Claus and Sedgwick, published by Swan Sonnenschein). The ostrich exhibits two claws on the fore-limb, which persist in the adult; *Rhea*, and among carinate birds the swan, have one so persisting. B. LINDSAY.

6.—**Rock-Salt and Gypsum.**—You would find an answer to your question in any elementary manual of mineralogy. 1.—Rock Salt is formed by the evaporation of the waters of some ancient sea, in a geological epoch, when the level of the land was rising. Arms of the sea would, under these circumstances, presently become small inland seas, and these would gradually be dried up, depositing their salt on the surface of the land, so as to result in a salt plain. The Dead Sea is held to be an instance of a sea so isolated, and there are many other instances. Although this is the origin of rock-salt, as found in geological deposits, it will be obvious that it leaves the primary origin of salt as a mineral unaccounted for. How did the rock-salt originate? From the sea. How did the sea get its salt?—Presumably by dissolving it from the land. This reminds one of the famous problem raised by the

wise owl, in Anthony Froude's delightful story of the Cat's Pilgrimage (itself a fine sample, by the way, of *salt*, of the Attic variety) :— *Whether, in the beginning of all things, did the owl first arise from the egg, or the egg from the owl?* The ovian problem we must leave for the ornithologists to settle, or the owls, whichever are the wisest : with regard to the salt, the solution is probably quite simple. Sodium chloride is exceedingly abundant as an element in our globe. The hydrogen flame, as every tyro in chemistry knows, shows the yellow flame of sodium, if you only shake the table, or walk across the room, thereby shaking a little impalpable dust into the flame. The sea, as the great reservoir into which all waters flow, contains the total result of their æonic work of solution, accomplished as they flow over the earth. Each stream brings down some infinitesimal portion of salt, which is left behind in the sea when the continually added water is removed by evaporation. "Mony a little maks a mickle," and the salt which is imperceptible, as an ordinary constituent of the soil, or of running waters, is manifest enough in the ocean brine, and in its evaporated deposit. It may be remarked, that rock-salt is a comparatively rare mineral, since it depends for its accumulation on the exceptional conditions named, and a very short-lived one, because it is no sooner deposited than the neighbouring streams begin to dissolve it again, forming the brine springs, which always accompany a salt deposit, and are often of nearly as much commercial value as the rock-salt itself.

2.—Gypsum (crystallised hydrous sulphate of lime).—Sea-water contains a minute quantity of the substance of this mineral, crystals of which may be observed, when sea-water is evaporated under the microscope. It is consequently found associated with rock-salt, as the natural evaporative product of sea-water. Its chief source, however, is the very common mineral pyrites (iron bisulphide). This, in the presence of air and moisture, gets a part of its sulphur oxidised, and reacts on any neighbouring deposit of limestone (carbonate of lime), so as to form gypsum.

B. LINDSAY.

Query.

8.—Weather Notes.—The country people in the Isle of Man say, it is a sign of storm when you see the fire reflected in the glass of the window so clearly, that it looks as if the fire were a real one situated out in the street. This is, I suppose, due to the existence of a film of mist, condensed against the outside of the window pane, when the air is very moist, this film converting the glass into a mirror.

Another sign of storm is said to be the appearance of blue flame in the fire. Can anybody tell me whether the proportions of carbonic oxide, formed by an ordinary fire (since this is of course the gas which gives rise to the blue flame), would be affected by variation in the atmospheric pressure, and in what manner? I can imagine that a real relationship of that sort may exist between the blue flame and the state of the weather.

Another "sign of storm" is a halo round the moon, of which, it is said, the further off the halo from the moon, the further off the coming storm. Can anybody corroborate this, and give an explanation of the distance of the halo? We had a fine example of the distance of the halo a few weeks ago, its diameter occupying, I should think, quite 45° of the sky.

Yet another "sign of storm" receives from the fishermen the names of "dogs" or "weather-heads." These are like a small round piece cut out of a rainbow; they appear to be about the size of the sun, and round in shape, though presenting the colours of the rainbow in vertical stripes; they are seen among distant clouds. Can anyone tell me their scientific name, and explain how they are produced?

The rising mist seen quivering over the surface of a meadow is yet another storm sign; the name given to it is *slienaine.* How is this mist a sign of storm? Then the curlew is said to fly *high* before a storm. I had always thought that all birds flew *low* before a storm; can anyone explain this, or is it a mistake?

The Manx are very wise in weather lore of all kinds: for instance, if the frogs lay their spawn at the edge of the pond, it will be a wet season; if in the middle, a very dry one. I suppose the frogs have some special means of communicating with the clerk of the weather. B. LINDSAY.

Half-an-Hour at the Microscope,

With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

In arranging the slides so as to get a clear idea of what is prepared for the banquet, I place *Crystals* first; then going on to organised structures in increasing complexity, should take *Diatomaceæ* (low algæ); *Fungi; Higher Plants* (tuber and root structure); *Protozoon; Entozoon; Polyzoon; Annelid; Insect; Vertebrata* (Dermal structure). Imagine the mind like a room with

shelves and cases; each fact gained to be carefully laid by, as it were, arranged and ticketed so that it may be readily found at any time when wanted, and collected with corresponding facts.

Stauroneis fulmen really deserves a less off-handed mode of treatment than it receives (see p. 126). It is a very elegant and interesting stranger, having been described by a dear and valued friend of mine, J. Brightwell, N. S. Wales. The description with figures will be found *Quarterly Journ. Micro. Sci.* for 1859, p. 179, and Pl. IX., Fig. 60. By a clerical error Ralph has attributed its discovery in "Pritchard's Infusoria," p. 911, to De Brebisson.

Grammatophora.—A useful way of preparing these filamentous Diatomaceæ may be mentioned. This is to *float* a very small quantity of the material on to a glass slip, and well dry it; the endochrome almost disappears, with the gelatinous cushions uniting the frustules at their alternate ends, or these may be entirely removed if thought well by heat from a spirit-lamp.

Bulgaria inquinans (Pl. XIII., Figs. 1 and 2).—In connection with the account given on p. 124, I may add that some of these sections, which can be scarcely made when matured, in their entirety, may be so when the plant is first passing into this condition, with the tissue formed, but not yet fully hardened. It is so with *Pteris crispa*, an object noted as hard to cut, since the woody portions become dense and resist the knife, whilst the cellular grow either weaker or atrophy, and crush under the force needful in making the section.

Some of the larger *Peziza* may be cut with ease throughout, so as to show corresponding parts to those here seen beautifully.

The relationships between Fungi and Lichens are highly curious and interesting and so strong, that we need not wonder at some "advanced" botanist throwing them together, to the discouragement of the student, and (as it appears to me) without any equivalent gain to the cause of science. Such a course is only calculated to lead to confusion in the long run, whilst seriously embarrassing, in the meantime, to those who, not having knowledge, yet earnestly desire to gain it.

The paraphyses are not male organs, but rather equivalent to the hairs of plants serving to separate the asci, and facilitate the access of air and moisture to them. The male organs, where known, appear only in an early stage, and resemble the stylospores and sterigmata of Lichens. The radiating appendages to capsules of the *Erisiphei* furnish a valuable specific distinction, and one which is easily observed. In the example under notice, they are short, simple, and semi-erect; with some they are furcate at their tips, branched simply, or beautifully sculptured. The best way

to see the arrangement of the spores in their cases is to crush one or two of the capsules on a slide when about ripe; they may be easily and well preserved in glycerine. It may not be without interest to remark that the usual number of spores in each ascus with *Erisiphei* appears to be 2, with *Bulgaria* as seen here, 4; but with the *Ascomycetes* in general 8, or a multiple of it, is the usual number.

Aleurone seems to me to be a mysterious and somewhat questionable thing, which (although it will not do to finally dismiss it in this way) still really "seems to be one of those things no fellow can understand as yet." Nice work for the winter, when nuts of various kinds may be readily procured, to enquire into it. A description of Aleurone will be found in the Microscopic Dictionary, 3rd Ed. See also p. 125.

Sonneratia section (see also p. 127).—All roots have more or less of the structure here shown: large porous ducts, with medullary rays, also sometimes pitted. One of those beautiful recondite marks of distinction which arrest the thoughtful student now and again, has not been attended to in making this section. This is the presence or absence of branched liber-cells, which might serve for a criterion as to whether its right botanical place were among the Mangroves or the Myrtles.

Fibres of Keratose Sponge (Pl. XIII., Fig. 3).—With regard to this slide I differ decidedly from our vivacious friend (p. 125).

This object is exceedingly interesting, When we remember the near relationship of the Sponge Animals (flagellated Infusoria) to the *Amœbæ*, their power, though seemingly so structureless and helpless, of building up complicated scaffolding,—look at the wonderful way in which the beams (we might say) interlace and occasionally become fused, like so many drawn-out strings of viscid material become hardened as soon almost as formed,—we may well feel delight as we gaze. The structure is so peculiar that it deserves permanent record, and though incapable at present of giving the name, I feel, for my own part, little doubt that both species and genus may be revealed from the fragment.

Dark-field Illumination.—I believe the credit of the simple mode of dark-field illumination alluded to by one of our members, belongs to our valued friend, Col. Horsley. As it is desirable our members should know the plan, and it may be some time ere this request reaches him, he will, for their sakes (I trust), pardon my saying in his name that it is "done by taking the light in a plane with the object, and dispensing with the glass reflector and the condenser, so that the only reflected light is derived from the

inside of the short plated tube under the stage of the microscope; the luminous rays thus faintly and obliquely transmitted prove quite efficient in rendering the markings on *Pleurosigma* plainly visible under objectives of $\frac{1}{4}$-in. focus."

TUFFEN WEST.

Selected Notes from the Society's Note-Books.

Pupa of Gnat.—In this object the imago may be distinctly seen beneath the pupa skin, wings, legs, antennæ, proboscis, etc., and ready to emerge. The escape of the insect is a curious and interesting sight, and not difficult to be seen, but it is soon accomplished and hence requires promptitude to witness. In this respect it differs from the Dragon Fly, which according to my experience requires two hours to perfect its transformation. This sight is still more interesting. [On Plate IV., Vol. 4, will be found copies of four drawings by Mr. West, showing the development of the imago within the pupa case. On p. 44 of the same volume is a description of the plate.—Ed.] FRED FITCH.

Filaria Bronchialis from a Calf (Pl. XIII., Figs. 4, 5, 6).—These animals are found in great numbers in the bronchial tubes and tracheæ of sheep, calves, fowls, turkeys, etc., giving rise to the "Husk" in the former, and what is known as the "Gapes" in the latter. The ova are supposed to be taken in either through the water or grass. Some species of this entozoon are found in man, giving rise to a disease very fatal in tropical countries.

The best treatment for animals affected with Husk or Gapes is the vapour of turpentine, the animal or fowl being placed in a box with a false bottom covered with shavings sprinkled with spirit of turpentine. Some adopt the more heroic treatment of pushing a feather moistened with turpentine down the throat.

THOS. PARTRIDGE.

Section of Medicinal Leech (Pl. XIII., Figs. 7—11) shows the muscular system admirably. The course of the individual fibres is readily made out, and they appear divisible into the following groups:—

1st.—Immediately under the skin is a sphincter-like circular layer of fibres, seen in profile in the transverse, and as red points in the longitudinal section.

2nd.—A layer of oblique interlacing fibres, crossing each other like the threads in a piece of cloth, and at their superficial ends running up vertically to the surface.

3rd.—A layer of straight longitudinal fibres, seen in profile in the longitudinal section and cut across in the transverse section.

4th.—Bands of fibres running like trabeculæ across the cavity of the body from the dorsal to the ventral surface, and losing themselves at either end among the other layers; they are seen in profile in both sections; these no doubt give the flattened form to the leech's body. I cannot make out any striæ in the fibres.

In the transverse furrows of the skin are seen in the longitudinal section the "segmental organs." These are tubular involutions of the integument which secrete the mucus with which the body is smeared; they seem to be rudiments of the tracheæ of insects.

The folded membranous structure seen in the centre of the body in the longitudinal section with fine parallel muscular fibres is, I suppose, the alimentary canal, and the open spaces the gastric cœca seen in section. Neither end of the body is shown.

H. F. Parsons.

Erysiphe Martii.—The so-called "spores" of this fungus are really the peridia or capsules. Each has a number of radiating appendages; they are too opaque when mature to allow their contents to be seen, but each contains a number of minute oval brown spores, not loose, but clustered together in rows in the interior of transparent spore-cases or "asci."

H. F. Parsons.

Bulgaria inquinans.—To illustrate the fructification of the ascomycetous fungi, I enclose a slide of *Bulgaria inquinans* (a suggestive name). It is a coal black, top-shaped fungus of a tough gelatinous consistence, and an inch or so in diameter, not uncommon on dead trunks, especially of ash trees.

The receptacle or body of the fungus is made up of a light brown, elastic, gelatinous stroma, which under a high power is found to consist of flexuous, branched, interlacing fibres, very like the yellow elastic tissue of animals. Immediately beneath the hymenium the stroma is darker in colour. The hymenium or spore-bearing membrane forms a flat disc with a raised border on the upper surface. Under the microscope it is found to be made up of long club-shaped asci in all stages of development mingled with curled threads (paraphyses), the use of which is not known (possibly they are male organs). Each ascus contains a row of dark brown oval spores. As the duration of the plant is comparatively long, and the formation of the spores is continually going on,

many millions must be produced by a single individual. The asci are erect and attached by their narrow end to the surface of the stroma, but owing to the toughness of the latter and the brittleness and opacity of the hymenium, great skill is required to make a section of the whole plant sufficiently thin to show the parts *in situ.*

H. F. PARSONS.

Santonine Crystals, prepared by dissolving Santonine in Chloroform, then dropping the solution on a hot slide and subsequently mounted in Castor Oil. C. F. TOOTAL.

Section of Potato, showing one or two interesting points, notably some minute sieve tubes, lying in rows of several near the vascular system, of which indeed they form a part. They will require a rather high power and careful illumination. The slide also shows crystals of aluerone.

H. POCKLINGTON.

Aluerone.—Is aluerone soluble in water? The crystals had evidently disappeared in or immediately after mounting. Can any one give an exact account of this substance?

J. ABBOTT.

Polarising Objects.—All structures capable of showing varied colours under the influence of polarised light are not necessarily legitimate "Polariscope objects," though popularly classed, sold, and bought as such. W. TEASDALE.

Cellularia avis.—This polypidom of a zoophyte unfortunately depolarises light, and so may be exhibited as a chromatically confused pretty object, instead of being intelligently considered under suitable illumination. It is a caution to mount such objects opaque that they may not be trifled with.

W. TEASDALE.

Sponge Fibre.—The dark field of the polariscope (without selenite) offers some little advantage over other means of viewing this object *as it is mounted*; "red selenite" is an aggravation to be avoided. Chance snips at the chitinous endo-skeletons of sponges whether picked up on the beach or in the bath-room, may furnish "gorgeous" micro-objects, but not highly instructive ones.

W. TEASDALE.

Crystal Slides.—I avail myself of this opportunity of putting in a note on the various means by which forms of crystallisation may be modified, and how some particular abnormal forms of crystals may be obtained.

1st.—By using various solvents.

2nd.—By varying strength of solution.

3rd.—By varying temperature during the process of formation.
4th.—Fusion by heat.
5th.—By the addition of celluloid matter to the solution (preferably Silicate of Soda as being inorganic and exceptionably stable).
6th.—By stirring the solution during evaporation, or allowing it to remain quiescent.
7th.—By allowing particles of dust on the slide to act as nuclei, around which acicular crystals may gather in stellate groups.
8th.—By the state of the surrounding atmosphere—moist—dry—or charged with vapour of ammonia—sulphur—alcohol—benzole, etc.
9th.—By colouring solutions with magenta, etc.
10th.—Compound forms of double and treble salts and substances.
11th.—By dropping a saturated solution of a salt not soluble in alcohol into alcohol.
12th.—Gradual change occurs occasionally, sometimes soon after mounting, sometimes after the lapse of years.

From this it will be seen what a wide field there is for easy and pleasing experiment, especially as I have by no means exhausted the methods of modification, but only suggested a number of them for selection and application to such substances as may be suitable. W. TEASDALE.

Mounting Crystals in Castor Oil.—It is very odd that specialists who work at chemical preparations do not find out something nicer and not so greasy as Castor Oil to mount these crystals in. My stomach turned against it from the very first, and led me to adopt various dodgy ways of getting mine safely embalmed in balsam. W. TEASDALE.

[It is much to be regretted that Mr. Teasdale has not made known to the Society *some*, at least, of his various "dodgy ways" by which slides of crystals may be "safely embalmed in balsam": we have studied the question for the last 15 years, and have not yet found a solution applicable to every kind of crystal.—Editor.]

Stauroneis fulmen.—Not being a "Diatomaniac," I cannot go into extacies over this solitary Lilliputian's tip-cat, despite its imposing name and dignified isolation, and am so ignorant in the matter of diatoms as to call all these double-enders simply *Navicula*, or little boats. Many learned particulars about Gyrosigmas, Pleurosigmas, etc., are doubtless to be found in the scattered "Transactions of the (unincorporated) Society for the Confusion of Useless Knowledge," and when "diffraction gratings" have

had a fair innings against immoderately wide-angled objectives, we shall get a corrected abstract for easy reference.

W. Teasdale.

Section of Medicinal Leech.—I congratulate Dr. Parsons (p. 123) on his highly intelligent inquest on the body of this *annelid.* A superficial observer would probably have contented himself by saying that (both extremities being wanting) he could make neither head nor tail of it. In the absence of any note as to how it came into the box, we are left in doubt as to whether this crimson *worm* is to be considered an *anatomical* slide, taking high and confident rank above little bits of insects and "such common things," or not. Previous contributions from the same source led me to suppose we were to draw the line of *anatomical* distinction, so as to exclude all animals without the dignity of a back-bone. Possibly, professional sympathy with his humble and useful coadjutor in the healing art, may dispose its owner to give the Medicinal Leech such a brevet rank above its strict zoological status.

Washington Teasdale.

Sonneratia.—This plant was introduced to English horticulture about fifty years ago, and its cultivation as a stove evergreen has not been kept up. Its botanical status is somewhat uncertain. Accepting the name the elder Linneus conferred upon it, *Rhizophora Cassiolaris*, it is a Mangrove, and where the Mangrove grows so does it in rich luxuriance. The younger Linneus is sponsor for the name under discussion. He gave it in honour of M. Sonnerat, and so preserved the name of a worthy botanical traveller from oblivion; but in so doing he makes it a Myrtle, and by observed peculiarity of inflorescence or fructification, its first-cousinship to the Pomegranite is not only claimed, but, according to present prevalent authority, is acknowledged. The plant has a high economic value, and even an æsthetic one; but what concerns microscopists is its minute structural peculiarity. In Bombay it is known under the native name of *Tewar.* It is equally abundant in the Loondubunds, on the other side; but, no doubt, has a different name at Calcutta.

W. Teasdale.

Ditto.—In Calcutta the strong, close-grained wood of *Sonneratia apetala* is used for making packing cases for beer and wine.

E. E. Jarrett.

Castor Oil for Mounting.—I would suggest that instead of using this medium for Mounted Crystals where C. Balsam changes their character or dissolves them, Glycerine should be used.

W. Sargant, Jun.

Filaria Bronchialis.—This is very different to the worm that I have taken from the throats of chickens and known as the "Gapes." I think the scientific name of the Gape worm is *Sclerostoma syngamus.* S. A. BRENAN.

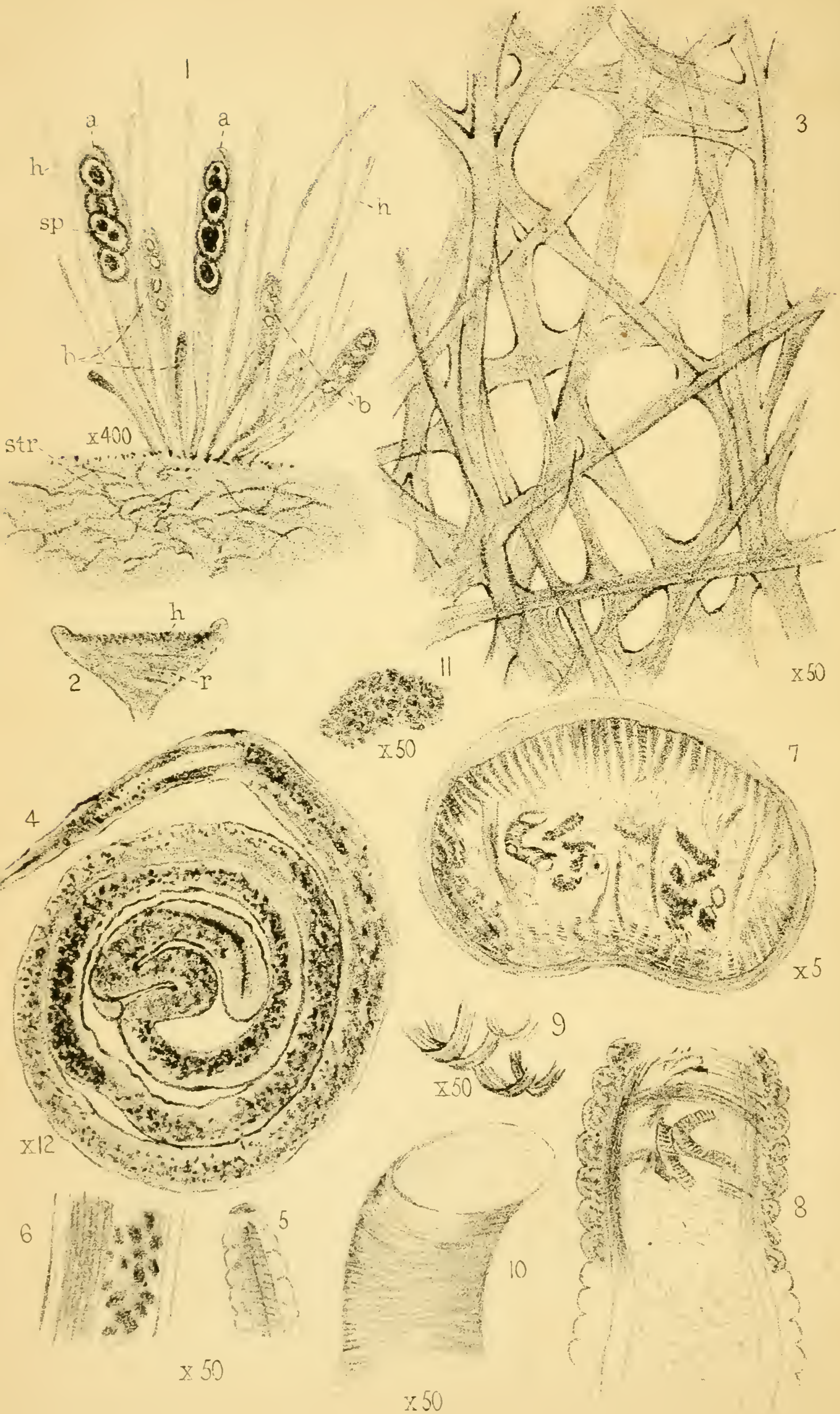
Bulgaria inquinans is figured and described on p. 732 of "Cooke's Handbook of Brit. Fungi," 1871, and is there said to be found on Oaks, etc. JOHN FORD.

Spiral and Scalariform Vessels.—Sections of Fern show the latter arrangement. *Spiral vessels* may easily be seen by partly cutting through many vegetable structures, such as the stalk of a Geranium leaf, and then breaking and drawing the divided portion asunder. If not too deeply cut, the parts are held together by the stretched spiral vessel, the rings of which had been lying in close apposition. Both forms of vessels are beautiful under the microscope.

J. D. BROWN.

Halo Slide.—I do not know what fungus was the parent of the spores contained in this slide, but I have been told that the spores of the Truffle when mounted have a similar effect. I suppose the effect is owing to the spores, and not to the medium in which they are mounted. To see the effect well there should be only one small light in the room, as the flame of a candle or small gas jet, and the light should be looked at through the object at a distance of about 10 feet. G. D. BROWN.

Halo Slides.—These slides are prepared from the spores of Truffle (probably *Tuber cibarium*). Truffles are more common in this country than is generally supposed. In the contributor's slide the spores, being unripe and tolerably transparent, appear to have been mounted *dry.* But in a "Halo" slide, by the same preparer, in my own possession, I observe the spores are a dark brown, and appear to be mounted *in balsam*, and in this latter the diffraction spectra are very much larger, brighter, and more numerous. Probably this curious optical effect would be produced by the sporangia of other fungi, such as those of *Lycoperdon* (the Puff-ball). Hastily glancing over my cabinet of Cryptogams, I find several slides which show the so-called "Halo," notably one of *Lycopodium* sporules, in which the circular iridiscence is particularly fine. As to the cause of this, it would be difficult, if not impossible, to pen any short explanatory note which would be intelligible to those unacquainted with the laws and varied phenomena of diffraction. One of the best popular works of reference on the subject is Lommell on Light (King and Co., 5s.). All those who use either Microscope or Telescope may study this section of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the book to advantage, and learn how to interpret their observations, for assuredly in many cases "things are not as they seem." The *Quekett Journal*, No. 38 (Oct., 1878), contains an excellent article on "The Influence of Diffraction in Microscopic Vision," by Mr. Frank Crisp, F.R.M.S., which may be studied with advantage.

Many slides show most varied and curious diffraction spectra, when closely looked through at a *distant* light; notably, Feathers, Hairs, Fabrics, Fish Scales, certain Membranous Wings, Leaves of Endogenous Plants, Longitudinal sections of various Woods, etc. etc. Fine rulings on glass (2000 and upwards to the inch), especially radial bands and cross angular ruling, give brilliant and well-defined spectra; but the most remarkable spectrum I ever saw was obtained by looking through the Palate of a *Limax*, mounted many years ago in balsam. W. TEASDALE.

EXPLANATION OF PLATE XIII.

Fig. 1.—*Bulgaria inquinans.* *a.a.*, asci, with their contained spores, *sp.*, in the mature condition; *b.b.*, immature asci, segmentation in various stages of development; *p.p.*, paraphyses; *str.*, stroma, a gelatino-corneous material, with delicate interlacing filaments interspersed throughout its substance, × 400.

,, 2.—Diagrammatic sketch by Dr. Parsons, showing, *r.*, receptacle; *h.*, hymenium.

,, 3.—Shows the remarkable interlacement of the fibres of Keratose Sponge, solid in the young state, but becoming tubular with advancing age, and cohesion of the fibres in many places where they come in contact, × 50.

,, 4.—*Filaria bronchialis*, the entire worm, as seen with a low power, × 12.

,, 5.—The head, with mouth, and very muscular œsophagus, × 50.

,, 6.—Part of body of the worm, showing piece of intestine, ovary, and nearly ripe ova, × 50.

,, 7.—Transverse section of Medical Leech, × 5.

,, 8.—Longitudinal section of same, shown also with low power.

,, 9.—Portion of the intermediate layer of muscles, unstriped, × 50.

,, 10.—Part of the longitudinal vessels, with delicate spiral *muscular* fibre coiled round it. There are but two coats, the inner an exceedingly thin membrane.

,, 11.—Portion of glandular structure appended to the intestine, × 50.

All drawn by Tuffen West except Fig. 2.

Reviews.

PRACTICAL MICROSCOPY. By George E. Davis, F.R.M.S., F.I.C., etc. etc. New and revised edition. 8vo, pp. viii.—436. (London: W. H. Allen. 1889.)

We are pleased to welcome a new and revised edition of this very useful book. The aim of the author has been to furnish such information as would enable the microscopist to thoroughly understand the instrument, and the principles on which it is constructed, and to initiate him into the art and mystery of those operations which go hand in hand with scientific enquiry. The work is illustrated with 310 illustrations and a coloured frontispiece, showing fine double-stained sections of typical forms of wood, viz., Clematis, Dog Rose, Eucalyptus, Gout Weed, and Black Pepper. A number of recipes at the end of the book will doubtless be found useful.

A MONOGRAPH OF THE BRITISH UREDINEÆ AND USTILAGINEÆ, with an account of their biology, including the methods of observing the germination of their spores, and of their experimental culture. By Charles B. Plowright, F.L.S., M.R.C.S., etc. etc. 8vo, pp. viii.—347. (London: Kegan Paul, Trench, & Co. 1889.) Price 12s.

We have here the Uredineæ and Ustilagineæ very carefully described, also an account of their life-history, as far as it is at present known. At the cost of much labour and a considerable expenditure of time, the author has compiled from the various handbooks, transactions, periodicals, and other sources, the materials found in the pages of this work. The result being a very exhaustive treatise on this branch of the fungus kingdom. The book is illustrated with wood-cuts and eight lithographic plates.

DIE NATURLICHEN PFLANZENFAMILIEN. Edited by A. Engler and K. Prantl. (London: Williams and Norgate; Leipzig: Wilhelm Engelmann.)

Nos. 24 and 25 of this important work are now before us. No. 24 contains the first part of the description of the Rosaceæ, by W. O. Focke; it contains 140 anatomical and other figures. No 25 is a continuation of the Orchidaceæ, and contains 183 figures. Every subject is treated in a most thorough and exhaustive manner, and all the engravings are well executed. The subscription price to this work is 1s. 6d. each part.

JOURNAL OF MORPHOLOGY. Edited by C. O. Whitman and Edward Phelps Allis, Jun. Vol. II., parts 1 and 2; pp. 338. (August and Nov., 1888. (London: W. P. Collins, 157, Great Portland Street. Boston, U.S.A.: Ginn & Co.)

The second volume of this fine work is in no way inferior to the first, and the ten papers which it contains are of great interest. They treat of the structure of the Gustatory organs of the Bat, by F. Tuckerman, M.D.; The Tritubercular Molar in Human Dentition, by E. D. Cope; The Seat of Formative and Regenerative Energy, by C. O. Whitman; The Internal Structure of the Amphibian Brain, by Prof. H. F. Osborn; Studies on the Eyes of Arthropods, by William Patten, M.D.; The Development of Manicina Areolata, by H. V. Wilson; The Structure and Development of the Visual Area in the Trilobite, by John M. Clarke; Further Studies on Grammicolepis Brachiusculus, by R. W. Shufeldt, M.D., C.M.Z.S.; The Relations of the Hyoid

and Otic Elements of the Skeleton in Batrachia, by E. D. Cope ; and on the Affinities of Aphriza Virgata, by R. W. Shufeldt, M.D., C.M.Z.S.

The two parts composing Vol. II. contain thirty-eight fine lithographic plates, several of them coloured and many of extra large size.

A MANUAL OF THE VERTEBRATE ANIMALS of the Northern United States, inclusive of Marine species. By David S. Jordan. Fifth edition, 8vo, pp. iii.—375. (Chicago, U.S.A. : A. C. McLurg & Co. 1888.)

The design of the book before us is to give to students and collectors a ready means of identifying the Vertebrate fauna of the region it covers, and of recognising the characters on which the families, genera, and species of these animals are founded. The descriptions are given in an exceedingly clear and concise form. Prof. Jordan finds 1145 species ; these belong to 607 genera ; the genera belong to 203 families, and 54 orders, and 7 classes. At the end of the book is a good glossary of technical terms, and a very full index.

A DICTIONARY OF PHOTOGRAPHY for the Amateur and Professional Photographer. By E. J. Wall ; containing concise and explanatory articles, illustrated by many specially prepared diagrams. Crown 8vo, pp. ii. —237. (London : Hazell, Watson, and Viney. 1889.) Price 2s. 6d.

Our readers will be glad to know, that the Dictionary of Photography, which ran through a number of the weekly parts of the Amateur Photographer, may now be had in a compact form. It is written throughout in plain, understandable language, and being arranged alphabetically, will be found a most convenient book for reference.

THE INTERNATIONAL ANNUAL of Anthony's Photographic Bulletin. Edited by W. Jerome Harrison, F.G.S., of New York, U.S.A. Post 8vo, pp. xix.—643. (London : H. Greenwood and Co., York Street, Covent Garden. New York : E. and H. T. Anthony. 1888.)

A large amount of very valuable information to the photographer, whether professional or amateur, will be found here. In the list of contributors, we notice more than 200 names, many of them being well-known in the profession. Several of the papers are illustrated, and in addition there are 6 or 7 Photographic and Photo-Mechanical Plates. We should think that photographers could not afford to be without this work.

PHOTOGRAPHIC MOSAICS: An Annual Record of Photographic Progress. Edited by Edward L. Wilson. (New York : E. L. Wilson. 1889.)

This is the 25th annual appearance of this old-fashioned but valuable work, and contains a large amount of valuable and very practical articles on every conceivable subject in relation to the "craft." It is, besides, embellished with a number of beautiful plates, specimens of Photo-Engraving, Albertype, Moss Type, etc. Amongst the plates is a fine portrait of Sir Morell Mackenzie, a Moss Type print by the Moss Engraving Co.

ZAEHNSDORF'S SELF-BINDING MOUNTS. The Eastman Dry Plate and Film Company, 115, Oxford Street, London, W., have favoured us with a specimen of Photographic Album, patented under the above name.

By an ingenious device of double guards, or as we should be inclined to call them "hinges," to each mount, and by a plan of lacing through the outside of the covers, the album, when filled with photos, will not only open perfectly flat, but at any time the whole leaf, with photos attached, may be exchanged

for others. The size of the book sent us is $7 \times 5\frac{1}{2}$, intended to carry photos 5×4; it contains 25 mounts, and price is 3s. 6d., or with gilt or carmine edges 4s. 2d. Refills may be had from 1s. 2d. to 1s. 6d. per doz. The same firm sends us—

THE KODAK PRIMER.—The "Kodak" is one of the Detective Cameras now so very popular, by using which, the amateur may secure some fairly good results. We should not advocate any of the "Detectives," when it would be possible to use and properly focus an ordinary Camera, but where this cannot be done, we say, use the "Kodak."

LES LEVERS PHOTOGRAPHIQUES et la Photographie en Voyage. Premiere partie. Application de la Photographie aux Levers de Monuments et a la Topographie. Seconde partie. Opérations complémentaires des Levers Photographiques. Par le Dr. Gustave le Bon. (Crown 8vo, pp. 134 and 121. Paris: Gauthier-Villars et Fils. 1889.)

The author of these volumes was employed by the French Government in an Archæological survey of certain buildings in India, and as, on account of the heat and the rainy seasons, only 7 or 8 months in the year could be devoted to the work, it was evident that rapid progress could only be made by the aid of photography. In Vol. I. a full description is given of the methods employed for giving a photograph all the value of a measured drawing without detracting in any way from its artistic value. These advantages were obtained by a few simple additions to the camera; it thus became one of the simplest instruments for measuring horizontal and vertical angles, levelling, etc., and for ascertaining the heights of inaccessible objects. Vol. II. gives a description of several instruments which may be used by the traveller as an auxiliary to photography in measuring such parts of buildings as are not of sufficient interest to be photographed. It contains also chapters on the choice of Lenses, Technical Photography, etc.

ANNUAIRE POUR L'AN 1889. Publie par le Bureau des Longitudes. (Paris: Gauthier-Villars et Fils. 1889.)

Since its foundation in 1795, the Bureau des Longitudes has regularly issued an Annual. The present issue contains copious notes on the Calendar illustrated by an Almanac, showing the concordance between the following systems, viz.:—the Gregorian, the Julian, the Mahommedan, that of the French Republic, and the Coptic; there are also numerous astronomical, chemical, and other scientific tables.

Interesting accounts are given of the ascent of Mont Blanc as far as the Grand Mulets, and of an expedition to the summit of the Peak of Teneriffe for the purpose of scientific investigation. The Annual concludes with a report of the work of the Bureau for the past year.

RECORDS OF THE PAST. Being English Translations of the Ancient Monuments of Egypt and Western Asia. New Series. Edited by A. H. Sayce. Vol. I. Crown 8vo, pp. xii.—175. (London: S. Bagster and Sons.)

These translations consist of The Dynastic Tablets and Chronicles of the Babylonians; The Inscriptions of Telloh; Sin-Gashid's Endowment of the Temple E-Ana; An Erechite's Lament; Inscription of Tiglath-Peliser I., King of Assyria; The Assyrian Story of the Creation; The Babylonian Story of the Creation, according to the Tradition of Cutha; Babylonian Lawsuits and Judgments; Inscription of Menuas, King of Ararat, in the Vannic Language; The Ancient Hebrew Inscription of Siloam. The enterprise, of which this is the

first volume, is an international one, eminent scholars belonging to all nationalities having consented to take part in it.

Old Bibles. An Account of the Early Versions of the English Bible. By J. R. Dore. Second Edition. Small 8vo, pp. xvi.—395. (London: Eyre and Spottiswoode. 1888.)

The author gives an account of Tyndale's New Testament ; Tyndale's Pentateuch ; Sir John Cheke's Version ; Coverdale's, Matthew's, Taverner's, and the Greek Bibles; Whittingham's New Testament ; The Geneva Version ; The Bishop's Bible and New Testament ; The Rheims and Douai Version ; and King James's Version. In the Appendixes we have the Preface to King James's Bible of 1611 ; Notes on Welsh Bibles ; An Early English Version of the Epistle to the Laodiceans ; and a list of English Bibles and Testaments in the author's collection. At the end of the book are also a facsimile of map in Coverdale's Bible, 1535, and copies of title pages and specimen pages from the same and other old Bibles.

Introduction to the Study of Philosophy. By J. H. W. Stuckenberg, D.D. 8vo, pp. viii.—422. (New York : A. C. Armstrong and Sons. 1888.)

This work is intended to be simply what is implied by the title, and everything has been adapted to this specific aim ; we are told in the preface that it is not an encyclopædia, nor is it intended as an introduction to any particular philosophical system, but to the study of philosophy itself. The book was written for students and others who desire to prepare themselves for philosophic pursuits.

Modern Science and Modern Thought. By S. Laing. Sixth Edition. Containing a supplemental chapter on Gladstone's "Dawn of Creation" and "Proem of Genesis," and on Drummond's "Natural Law in the Spiritual World." 8vo, pp. xiii.—370. (London : Chapman and Hall. 1889.) Price 3s. 6d.

The object of the book before us is to give a clear and concise view of the principal results of Modern Science, and of the revolutions they have effected in Modern Thought. It is a book full of interest ; the first section of the work treats of Space, Time, Matter, Life, Antiquities of Man, and Man's Place in Creation. The second portion of the work deals more with the author's own reflections on the various subjects discussed. The supplemental chapter covers 59 pages, and is a critique on the three books mentioned on the title page.

Corona : The Bright Side of the Universe. Studies in Optimism. By F. T. Mott, F.R.G.S. Crown 8vo, pp. viii.—190. (London: Williams and Norgate. Leicester : J. and T. Spencer. 1888.)

The author dedicates his book to "The Grand Old Statesman, whose career bears such emphatic witness to the continuous evolutions of the human soul," etc. He says he has not set forth a complete body of philosophy, but has endeavoured to put light into a number of dark subjects in a popular and suggestive way. We have read every word of this book, but confess we cannot understand it all. Chap. II. on "Man" commences, "Man is not a Mammal. He cannot be more nearly related to the monkey than the 5000th cousin ; probably he is not so nearly related as the lizard is to the bird," etc.

The Native Races of the Pacific States of North America. Vol. IV., Antiquities. Svo, pp. ix. –807. (London: Trubner and Co. San Francisco: The History Pub. Co. 1880.)

This is to us the most interesting of the series of Historical Works that has yet reached us. It treats of Monumental Archæology, and presents a detailed description of all material relics of the past, discovered within the territory under consideration. In this volume, a map showing the "location" of the ancient monuments, and 395 wood-cuts are given to assist in the description of the Antiquities, which have for the most part been left by the civilised nations. After an Archæological introduction, we have first a description of the Antiquities of the Isthmus, Costa Rica, Mosquito Coast, and Nicaragua, followed by the Antiquities of Salvador and Hondurus, Guatemala and Belize, Yucatan, Tabasco and Chiapas, Cajaca and Guerrebo, Vera Cruz, The Central Plateaux Northern Mexican States, Arizona and New Mexico, The Northwest, Works of the Mound Builders, and Peruvian Antiquities.

Yorkshire: Its Scenes, Lore, and Legends. By M. Tait; with Maps, etc., by T. D. King. Square 16mo, pp. v.—100. (Leeds: E. J. Arnold. 1888.) Price 2s. 6d.

This very interesting work was elaborated from a prize essay, written for the Bradford Geographical Exhibition, 1887. It contains a large folding map of the whole County; Contour Maps of the Rivers and Valleys; Geological Map; and a large folding map of British and Roman Yorkshire, besides several plates of Abbeys and Remarkable Scenery. It is a book full of interest.

The Multum in Parvo Atlas of the World. (Edinburgh and London: W. and A. K. Johnston. 1889.) Price 3s. 6d.

Truly no better title was ever given to a book than is *Multum in Parvo* to this; its size is 5 by 3¾ inches, and about 1¼ inches in thickness. Besides a large amount of valuable letterpress information, it contains 96 double-page maps, nicely coloured and distinctly printed. At the end of the book will be found an alphabetical list of every place mentioned on the maps, and reference letters by which they may be easily discovered. This index occupies 112 pages.

The Illustrated Medical News. (London: The Illustrated Medical News Publishing Company, 376 Strand, W.C.)

This is a royal 4to weekly Medical Journal, and intended exclusively for members of the profession. No. 22 is a special number devoted to the study of *Osteitis deformans.* The frontispiece to this number is a fine lithographic plate, showing front and side view of two skeletons. Each number contains a lithographic plate often in many colours, and is further embellished with a number of wood engravings and photo-mechanical illustrations. No efforts are spared to make this Journal one of the leading publications of the day, and certainly no medical library can be considered complete unless it contains a perfect set.

The Medical Annual and Practitioner's Index. Crown 8vo, pp. xxviii., 598. (Bristol: John Wright & Co.; London: Hamilton, Adams, & Co. 1889.)

The 7th vol. of this well-known work is now before us. Its general contents embrace a variety of subjects. Part I. of this issue is devoted to New Remedies, by Dr. Percy Wilde; to this part are added two articles, one on *Mechano-Therapeutics*, or Massage, by Dr. T. S. Dowse; the other on *Electro-Therapeutics*, by K. Millikan, B.A., M.R.C.S.

Part II. is devoted to New Treatment in Surgery and Medicine, in which the names of diseases are arranged in alphabetical order ; the articles in this section of the work are written by leading authorities on the subjects of which they treat.

Part III. describes a number of new inventions, instruments, and appliances.

The title page contains the names of a long list of contributors, among whom we notice Sir Morell Mackenzie and several others of note.

The Physician as Naturalist. Addresses and Memoirs bearing on the history and progress of medicine during the last hundred years. By W. T. Gardner, M.D., LL.D. Crown 8vo, pp. x.—436. (Glasgow: James Maclehose and Sons. 1889.)

The first part of this interesting work is occupied by the speech of Professor Gardner, at the meeting of the British Medical Association at Glasgow, of which he was the President ; the latter part consists of various papers of considerable interest to the Medical Profession, and in many instances to the general scientific world.

The Physician's Leisure Hour Library. (Detroit, Mich., U.S.A. : George S. Davis. 1888.)

Two more of this valuable series have come to hand ; these treat of Bright's Disease of the Kidneys, by Alfred P. Loomis, M.D., LL.D., and the Modern Treatment of Diseases of the Kidney, by Prof. Dujardin-Beaumetz, translated by E. P. Hurd, M.D.

These volumes contain 169 and 117 pages respectively, and their price is 25c. in paper covers, 50c. bound in cloth.

Brain and Mind ; or, Mental Science, considered in accordance with the Principles of Phrenology, and in relation to Modern Physiology. By Henry S. Drayton, A.M., M.D., and James McNeill, A.M. Crown 8vo, pp. 354. (New York : Fowler, Wells, and Co. 1889.)

In this work, now in its sixth edition, we have a treatise giving the reader a complete view of the Science of Phrenology, exhibiting also its relation to Anatomy and Physiology. The author tells us, that the literature of Phrenology is not by any means lacking in fresh contributions from the pens of competent observers in Europe and America, but none have given more than a passing glance at the bearing, which recent experiments and observations by leading physiologists have upon the subject. It is illustrated with 124 engravings, many being portraits of well-known authors.

How to Read Character. A new illustrated hand-book of Phrenology and Physiognomy for students and examiners, with a descriptive chart. Crown 8vo, pp. 191. (New York : Fowler, Wells, & Co. 1888.)

This work we are told embodies the latest and best ideas on the subject, so far as they can be set forth in a condensed and popular form. It contains not only all of the Phrenology of previous charts or hand-books for self-instruction, but it embraces much more of Physiology and Physiognomy, than any former book of the kind. It contains nearly 200 illustrations.

Electric Bells and all about them. By S. R. Bottone. Crown 8vo, pp. viii.—190. (London : Whittaker and Co. 1889.) Price 3s.

As stated on the title page, this is a thoroughly practical book for practical men ; it gives full details as to the construction of batteries, bells, pushes, detec-

tors, etc., the mode of wiring, testing, connecting up, and localising faults, directs careful attention to every case that can present itself to the electric bell-fitter. It contains about 100 illustrations.

A COURSE OF ARITHMETICAL EXAMPLES FOR BEGINNERS. By J. G. Bradshaw, B.A. Crown 8vo, pp. viii.—180. (London: Macmillan and Co. 1889.)

This book, which we believe emanates from Clifton College, Bristol, will be found of great assistance to the schoolmaster, as it supplies a great number of easy and easily graduated examples. The work before us covers a full course of such examples, suitable for boys under the age of fourteen.

CATALOGUE OF FERNS. Cultivated by W. and J. Birkenhead, Fern Nursery, Sale, near Manchester. Price 1s. 6d.

This catalogue is something more than a list of Ferns offered for sale. It contains a list of over 1,400 species and varieties of Stove, Greenhouse, Hardy, Exotic, and British Ferns and Selaginellas. Under these subdivisions the genera are arranged alphabetically, with the species and varieties under each genus. The value of the book is much enhanced by the illustrations, which are beautifully engraved. The book consists of 130 pages. Pages 110 to 118 inclusive contain "Hints on the Cultivation of Ferns."

THE INVADERS, and other Stories. By Count Lyof N. Tolstoi. Translated from the Russian, by Nathan H. Dole. Crown 8vo, pp. 343. (London: Walter Scott. 1889.)

This volume contains the authorised translation of the following tales from the Russian:—The Invaders; The Wood-Cutting Expedition; An Old Acquaintance; Lost on the Steppes, or the Snowstorm; Polikushka; Kholstomir, a Story of a Horse.

LIFE OF JOHN STUART MILL. By W. L. Courtney. 12mo., pp. 194—xii. (London: Walter Scott. 1889.)

This little volume is one of the "Great Writers" series now being published by this enterprising firm. In the appendix is given the Genealogy of the Mill Family, a calendar of the lives of the two Mills (father and son), and a Bibliography, by John P. Anderson, of the British Museum.

ESSAYS OF WILLIAM HAZLITT. Selected and edited, with an Introduction and Notes, by Frank Carr. 12mo., pp. xix.—322. (London: Walter Scott. 1889.)

One of the "Camelot Series," edited by Ernest Rhys. A life of Hazlitt is given in the Introduction. The Essays, 25 in number, covering a wide range of subjects, were originally published in the *Examiner* and other similar papers about 1820

THE POETICAL WORKS OF GEORGE CRABBE (selected), with Prefatory Notice, Biographical and Critical, by Edward Lamplough.

POEMS BY DORA GREENWELL (selected), with a Biographical Introduction, by William Dorling. Crown 16mo, pp. xxiii.—255, and xxiv.—248. Price 1s. each. (London: Walter Scott. 1889.)

Two interesting volumes of the "Canterbury Poets" series. The poems are carefully selected. The biographical notices add considerably to the value of the books.

Histology of the Teeth: Notes on Methods of Preparation.

By V. A. Latham, F.R.M.S.

THE different methods of hardening, cutting, staining, and mounting which tissues must go through before they are ready for examination seem tedious at first; but when we understand the reasons, they are simple enough. As regards re-agents and stains, the fewer and simpler that obtain a given result the better, though when the student is able to use the ordinary stains he can always try others. I do not claim originality in the various methods here given, but have ventured to collect and modify some of the ways given to suit my own work, and to have at hand the principal ones known, or as nearly so as possible. The old method of cutting a fresh tooth into fine sections with a saw, grinding down fine, and thoroughly cleaning, polishing, and mounting in Canada balsam, is one of the best methods for hard sections when not required to show the pulp and more delicate structures. I will not enter into more detail of those methods, as I gave them in *The Scientific Enquirer*, Vol. II., p. 196.

To Grind Sections of Teeth.—I use *ground glass*, using with it in the early stage fine-ground pumice-stone, which is especially convenient for grinding rough shells, like those of lobster or crab. By soaking the jaw of a mouse, rat, weasel, etc., in a solution of balsam in benzole, allowing it to become hard, and then grinding down as above, very beautiful sections showing the teeth *in situ* may be made.

Structure of Softened Tooth.—

Vertical Sections of the jaw of cat should be softened in dilute chromic and nitric acid; mount in Farrant's solution or in glycerine jelly. The latter is preferable.

THE PULP of a full-grown tooth can only be investigated by breaking the tooth across with a hammer. The broken tooth should then be hardened for twenty-four hours in a one-fifth per cent. solution of osmic acid.

Break a fresh tooth, and place it in a saturated solution of picric acid. Add more crystals of the acid occasionally and stir until the tooth becomes soft, when transfer to alcohol. Change the spirit so long as it becomes tinged with the picric acid. This will preserve the pulp and odontoblasts. Sections can be now cut, stained with carmine (which double stains), logwood, etc., and mounted in glycerine or Farrant.

The DENTINAL SHEATHS lining the tubules may be isolated by boiling for ten minutes in strong sulphuric acid (1 per cent.).

The TUBULES appear to be calcified membranes, imbedded in a calcified tissue somewhat similar to that of bone. The latter disappears when boiled in the dilute acid.

The ODONTOBLASTS and Fibres of Tomes may be seen in sections of the teeth *in situ*, when they are very young and still within the dental sacs.

Carious Teeth.—Break them, and make sections from the portions which have become brown and deprived of their lime salts. But if one desires to follow the transition from healthy to diseased tissue more closely, the previous decalcification is good. Tingeing with carmine and iodine also renders good service.

Exner's Method.—Drop melted wax on the end of a cork until the tooth can be fastened in it. Then add more wax until the tooth is completely covered. Grind wax and tooth very carefully on an ordinary grinding stone which is turned with a handle. When a smooth surface has been obtained, soften the wax and remove the tooth. Embed it a second time with the ground surface downwards, and grind as before, until the wax can be seen through the tooth substance. Then finish with pumice-stone and a hone as for sections of bone.

Dentinal Sheaths.—To show these lining the tubules, a piece of *softened* tooth (10 per cent. hydrochloric acid) is transferred to *strong* hydrochloric acid (contained in a watch-glass, which is covered by another, inverted). Leave in this for an hour, after

which time only a tenacious soft mass will be found. Remove some of this with a small pointed piece of wood, place on slide, cover, and examine.

Study of Teeth *in situ.*—This is a good, instructive way to see the many features in one specimen. Take a rat's jaw, remove the flesh, soften with picric acid in the way above described; then immerse in spirit, embed, cut and stain with carmine—which is good for double stain with the picric acid—or, better, stain with picro-carmine and logwood and mount in glycerine. Besides showing teeth, the bone is well seen. At the lower part the constantly growing incisor, which extends in the rat below the molars to the back part of the jaw, exhibits the large, elongated odontoblasts of a developing tooth, with their well-marked dentinal processes (fibres of Lent), which in some parts project like harp-strings across a small space which intervenes between the cells and the dentinal substance. It will be remarked, also, that in these teeth the most newly-formed layer of dentine becomes, especially near its junction with the older parts, very intensely stained by the logwood. This is the case with all teeth which are still in process of development. Carmine does not exhibit the same action.

Development of Teeth.—Perhaps the most convenient animals to choose are new-born rats, since sections of their jaws exhibit not only the mode of development of the teeth, but also the hair, inferior maxilla (which ossifies in the connective tissue around Meckel's cartilage), the tongue, and many other parts. The fœtuses are decapitated and the heads dropped into a large beaker of one-sixth per cent. chromic acid. After a week's time, during which the liquid is now and then stirred, they are transferred to weak spirit, and in twenty-four hours to strong spirit. Leave in this for a day or two when they will be ready for cutting. Embed either the lower jaw separately, or the whole head may be placed in the mould, and both jaws cut simultaneously. Stain the sections with logwood, some in carmine (made by dissolving 2 grms. of carmine in a few drops of ammonia, and diluting with water to 100 cub. cent.) The earlier stages in the development of the teeth may be perhaps seen in the molar region; the later stages comprising the development of the dental tissues, especially the dentine and

enamel, may be studied in the much more advanced incisors, which, as just pointed out, extend backwards in these animals through the greater part of the length of the jaw.

Sections showing the Pulp.—As soon as the tooth is extracted, immerse it in alcohol till required for use. You will now require a lathe with emery wheels of 5 inches diameter and $\frac{3}{4}$ of an inch thick, also a small felt wheel for a pad to hold the section whilst cutting. Hold the specimen to the circumference of the wheel with the thumb and finger of each hand. Cut down the tooth on each side until the pulp is seen, sliding the tooth backwards and forwards across the wheel in order to grind evenly from the crown to the apex of the root. Keep the wheel wet with distilled water. Now return the tooth to alcohol, and keep it there for a short time (half-an-hour). When again grinding, use the flat surface of the same wheel, cutting first one side and then the other, until the section is about one-eighth of an inch thick. Now use the finer wheel, and go from that to the finest for the last polishing, returning the section occasionally to alcohol for a few minutes in order to keep the pulp as hard as possible. Use the felt wheel as a bed for the section while grinding. Cut the tooth on each side alternately to insure taking the section from the centre of tooth. When thin enough, wash carefully in distilled water, and examine under 1-inch object-glass, to see that all the felt wheel fibres are washed from the pulp. Now stain the pulp with carmine, and keep the section in alcohol until ready to mount, when it should be immersed in clove oil, and then in thin balsam.

To demonstrate Protoplasm between the Fibres of the Enamel.—Decalcify teeth by means of chromic acid. Then cut sections, and stain in a solution of gold chloride, exposing to sunlight for twenty-four hours or more. Gold chloride is said only to stain when *fresh.* But I think, if examined and *more carefully* manipulated, this does not matter. I immerse my sections, either cut from a decalcified tooth or ground down from a hard one, in a solution of carbonate of soda for an hour. Then place in a solution of chloride of gold, *which must be neutral.* Leave in the dark for another hour. Again place in the carbonate of soda

solution for a few minutes, and then transfer to a 1 per cent. solution of formic acid. Keep warm over a water-bath for about an hour and a half, and mount in glycerine jelly, NOT Canada balsam. Sections which have been decalcified by chromic acid take longer to stain than those which are fresh ; but the whole process only occupies from three to four hours, instead of at least twenty-four hours, as in the old method, and the result is far more satisfactory. The usual needles, or any steel instruments, *must be replaced* by NON-METALLIC *ones*, such as a glass rod or quill tooth-pick, etc., for manipulating the sections.

A better way to classify dental microscopy is to divide it into *treatment* demanded by—(1) Hard Sections, (2) Softened Sections, (3) Sections of Pulp, (4) Sections of Tooth-Germs, etc.

Class I.—Hard Sections.

Choose your tooth, the fresher the better. You will find, with care, that two or three sections may be cut from a tooth by using a new, thin, gold file to cut through the enamel, wet with turpentine and soft soap, and then use a broad-frame saw for cutting through the dentine. The best way is to hold a section of tooth about one-eighth of an inch in thickness. You next flatten one side on a fine revolving corundum wheel (Ash's No. 9, fine), till one side is ground quite flat. Then polish that side to the most perfect polish it is capable of receiving on a piece of wet buff leather, with some putty powder on it. Afterwards take a piece of stout plate-glass, about 2 inches square. Put a little old and consequently tough Canada balsam on it, warm, and spread it a little larger than your section. Let the balsam cool down till it is "tacky"; then press the polished side of the tooth into close contact with the glass. When quite cold, the grinding may proceed, as in the first part of the operation, till you get the required thinness, when the side may also be polished. The hard balsam round the section supports and protects the edges, which will not be fractured (unless heated too much) and made jagged and untidy. In *not* putting the tooth on to glass till the balsam is somewhat cool, you prevent the polished surface from being covered by fine cracks, and also the balsam from running into the tubular structure of the dentine.

Another method is to grind the section till thin. Place it between two plates of ground glass with water and a pinch of levigated pumice powder, and by a rotatory motion of the upper glass gradually rub the section down till it is thin enough for examination with even the highest powers of the microscope. But great care must be used when finishing, as an extra turn of one of the glasses may ruin the whole section (old polished glass is now the best to finish with), and when sufficiently thin mount in Canada balsam. Canada balsam is not, strictly speaking, soluble in alcohol, but is converted by it into a white, pulverulent condition. Therefore, the plate having the thin section attached to it (first method) may be placed in alcohol, and in a few hours the section is easily detached without a fracture, but will be found coated with the altered balsam, every particle of which must be removed with a clean camel-hair pencil, kept constantly wet with spirit. If this is not done, the specimen will appear muddled and messy when mounted. Having got it quite clean, it may be placed with the other, which has been rubbed down between the glasses, in clean absolute alcohol till you want to mount it. Some will say this camel-hair pencil work might be dispensed with by placing the section into some complete solvent of balsam, such as chloroform, benzole, or turpentine, etc.; but be it remembered that by so doing we should bring about the very thing we have been trying to avoid—*i.e.*, to mount our section without the highly-refractive balsam rendering it invisible, and that is why the alcohol is recommended.

Mounting Teeth and Bone in Balsam.—There are two good methods for doing this:—

(1) Take your section out of the absolute alcohol, and let it dry; partially protect it from the dust, etc. When *nearly* dry, give it a good soaking in filtered, distilled water, that the tubules, lacunæ, and canaliculi may become filled with water; then dry its surfaces by wiping with a clean, warm finger, so that all moisture is taken from them, when the section may be mounted in rather firm balsam without the structure being destroyed.

(2) Plunge the section for a moment into an alcoholic solution of white shellac and quickly withdraw it. The alcohol evaporates,

leaving the porous structure completely *occluded* and protected from the balsam, however liquid it might be. By either method specimens of abnormal dental histology may be satisfactorily preserved.

To Exhibit in a recently-extracted tooth the state of relationship existing between its dentinal tubuli and the pulp.—These can only be made after decalcifying the tooth and hardening the pulp. Picric acid is often used, but for a ready solution that is generally to hand, there is none so effectual as a saturated solution of common alum, with about $\frac{1}{2}$ drachm hydrochloric acid added to each ounce of solution. Steeping the tooth in this for about three weeks leaves the tooth with a consistency of cork. If now it is soaked in glycerine for a few days, it may be embedded and cut into thin sections by any of the usual instruments. I think this method is preferable to either picro or chromic acid because it does not stain the hands, and (what is more important) does not produce so much granularity as they do. The section can now be stained and mounted.

Staining.—I now propose to consider the manner of using some of the different re-agents employed in *staining*, and will begin with **Logwood,** as it admits of almost universal application. The solution is best filtered just before using, and sections will be more advantageously coloured if the ordinary fluid is diluted, and the immersion consequently prolonged. If, on examination, it is found that the tissues are so deeply pigmented as to render them opaque, the excess may be removed by soaking in methylated spirit or in a half per cent. solution of alum.

Carmine.—The preparation recommended by Dr. L. Beale is, perhaps, the best. If, however, any of the carmine on keeping is found deposited, it may be again dissolved by adding a drop or two of ammonia. Leave the sections in it for at least twelve hours; but if found too deeply stained they should be washed with 1 per cent. solution of hydrochloric or glacial acetic acid. The acid brightens the colour. Tissues stained in carmine are best mounted in glycerine jelly.

The **Gold Chloride Method** will be found above (p. 140). The hard sections will, if stained with this re-agent, show fairly well

the general way and direction of the enamel fibres, but to obtain transverse sections exhibiting the fine striated appearance presented when the axial portion is removed by acids, requires a slightly different treatment. A method I have used with very fair success is to choose as young a tooth as possible. Cut off the enamel by the process previously described, and then grind one side (the inner for choice) flat on an Arkansas stone moistened with water. Then dry and mount on glass with old balsam, and very gently rub down the opposite side. Great patience and care must be used to avoid fracturing the specimen. To ensure this, keep the tooth very moist. When thin enough, free the section by soaking it in alcohol. Place it on a glass slide, and then apply hydrochloric acid (1 part in 15) on a camel-hair brush. Leave for four or five minutes. Wash the acid away with water, and examine under the microscope to see if the axial portion is removed, and if not it must again be treated with the acid. It should now be dried, and if mounted in Canada balsam the gum should be nearly solid before the section is introduced; but it is better mounted in glycerine jelly. Dr. Abbott recommends that the enamel, after being sectionised by the saw, should be carefully ground under water, and then decalcified by immersing it in a dilute solution of chromic acid for twenty-four hours. The solution is not to be stronger than $\frac{1}{2}$ per cent. Then stain with carmine, and mount in glycerine diluted with half of its bulk of distilled water.

Many other extremely useful stains might be mentioned, amongst which are the anilin dyes and nitrate of silver. The latter, however, should not be employed for staining dentine, but I think what I have discussed at length will be found to meet all ordinary requirements.

Class II.—Softened Sections.

Several re-agents may be used. All seem to act by removal of calcareous matter and the hardening of the soft tissues of the teeth. Chromic acid is the first. Half fill a pickle-bottle with water; then add chromic acid till the liquid is of a light straw colour; now tie a piece of cotton lightly round a *fresh* tooth and suspend it in the fluid, so as to be well covered by the solution.

Change the solution every two or three days, and it may be gradually strengthened till of a pale sherry colour. At the end of a week one or two drops of hydrochloric acid is to be added. When decalcified (test with needle), embed, and cut with a razor. Dip the tooth first in melted paraffin, and place it nearer the side next the operator, so that it comes quickly in contact with the knife. The "Army" razor is best, as it can be flooded with methylated spirit, and the sections floated off the knife into alcohol. To prevent the object from becoming displaced, it should be first immersed in alcohol for some minutes in order to dry the surface thoroughly.

To Embed in Gum.—If the tooth is in alcohol, transfer for six hours into distilled water, and then to a gum solution for six hours. Place a fair quantity of gum on the plate (Cathcart's microtome), and cool till nearly frozen. Place the tooth in position, and continue the spray till the gum is solid, when it will cut like cheese. No previous wetting is necessary, as the thawing of the ice keeps the knife moist. Place the sections in weak methylated spirit. If the sections are delicate and liable to break, transfer them from the knife to the slide, and treat them *in situ* with dilute spirit. These sections may be stained with carmine or gold chloride, and then mounted either in glycerine jelly or Canada balsam. A saturated solution of picric acid is preferable to chromic acid, as it causes less shrivelling than the latter. A less good one is a saturated solution of alum, with the addition of $\frac{1}{2}$ drachm of hydrochloric acid to 1 ounce of the alum solution. Dr. L. Beale softens the tooth by a prolonged maceration in glycerine, to which a few drops of acetic acid may be added to hasten the process.

Class III.—Sections of Pulp.

Crush newly-extracted teeth in a vice or with a hammer, and select several pieces of dentine with portions of pulp adhering to them. Then immerse them in carmine fluid, cover with paper, and leave in a warm place for a couple of days. Then pour the fluid off, and wash the specimens in a solution made of strong glycerine 2 parts, distilled water 1 part, and leave for a couple of hours to soak. To enable the tissues to regain their original

volume, transfer them to a solution of 5 drops acetic acid or to 1 ounce of strong glycerine, and leave in the fluid for four days.

To facilitate the Study of the Nerve-Fibrils, the pieces should now be transferred to 1 oz. of glycerine solution of acetic acid, to which enough strong chromic acid must be added to make an infusion of a pale straw colour. Leave for a week, and then imbed in gum. Cut as many mounts as required. These must now be examined in strong glycerine under (1-inch) low power, and the best sections, mounted in glycerine with two drops of acetic acid to the ounce, will show with higher powers. If you wish to keep any of these, draw off the superfluous fluid with blotting-paper, and the glass cover must be cemented to the slide by painting carefully a thin ring of marine glue or Ward's brown cement round it; when dry, a second or third coat may be added, and finally finish with white zinc.

If desired to **Study Blood-Vessels of Pulp,** chloroform an animal, and just before respiration ceases, open the right auricle and let the vessels empty themselves; then inject with Prussian blue, warmed to a temperature of 40 deg. C., to render the gelatine fluid and also to prevent any vascular spasm which a cold fluid is very liable to produce. Then place the head in alcohol for twenty-four hours to harden the injection; when the pulp is removed, immerse in a weak solution of chromic acid, and at the end of ten days sections of it may readily be cut, which are best mounted in glycerine jelly. If the animal is dead, you must wait till *rigor mortis* has passed off, and inject a *non*-gelatinous Prussian blue, but the first injection is the best. In some animals which have died of strangulation the vessels will be found so gorged with blood as to render any further preparation unnecessary.

Class IV.—Sections of Tooth-Germs.

Obtain a very young fœtus, 3 to 8 inches in length. Avoid all that have been kept in spirit, especially if it has been weak, or the epithelium will have peeled off, and the jaws will be useless for our purpose. Remove the head, place in a very weak solution of chromic acid (¼ per cent.), leave for from eight to ten days, when remove to alcohol to absorb water. Imbed in gum, freeze, cut,

stain the sections in carmine, and then mount in Canada balsam to render them translucent. Picro-carmine is an excellent stain. If they are not stained, they will be opaque from chromic acid and alcohol. To render them transparent, allow them to soak in oil of cloves. As most tooth-germs are taken from newly-born kittens and puppies, chromic acid maceration must be much longer and may be even extended to a couple of months; but the period may be shortened by the judicious use of an occasional few drops of nitric acid.

There are a great many hardening fluids; but a 1 per cent. solution of chromic acid is the best for our use, or 15 grs. of chromic acid and 2 cc. nitric acid, and 200 cc. water (Rutherford). Add the nitric acid *last*. If the softening is not completed in a month, place double the quantity of nitric acid in the fluid, or place them simply in dilute nitric acid (2 per cent.).

Staining in Carmine, Hæmatoxylin, etc.—Teeth may be mounted dry by grinding both sides down on an oil stone very thin; then polish on soft leather and finely-powdered pumice-stone. Mount in Canada balsam and benzole which has been heated, and then allowed to get *nearly* solid. Press the section down firmly, and then apply the cover-glass. In this way air-bubbles rarely get under the section.

Chromic Acid (1 per cent.) decalcifies as well as hardens. This is made by adding 30 grs. of acid to a quart of water. The tissue (as fresh as possible) should be put into the solution, and the fluid changed every other day for one week, and then left until completely decalcified. Then place them in 75 per cent. alcohol to remove the chromic acid. Tissues can be prepared in this way in any quantity, and kept in alcohol until needed. This is the usual method. For the demonstration of the *development* of teeth, I have used the jaws of fœtal kittens, dogs, rats, rabbits, and also sections of fully-developed teeth and sections containing the teeth *in situ*. Mr. Hunter (of Sands and Hunter, Cranbourne St.), London, has some fine preparations of the whole jaws, etc. Young fœtal pigs are also readily obtained in good condition. A series of these should be secured, ranging in length from one inch to six inches, the first presenting the begin-

ning of the development of the teeth, and the last being as practicable for study in the pig.

To Prepare the Material.—Disarticulate the inferior maxilla, and place each in a separate bottle filled with a 1 per cent. solution of chromic acid. Suspend the jaw in the fluid by means of a string; label, cork, and put away. After the jaws are completely decalcified—which can be ascertained by trying to pierce them with a needle—they may be imbedded in one of three ways.

First, placed between pieces of hog's liver, previously hardened in alcohol, and thin sections cut with a razor ground flat on one side. Very good sections can thus be made.

Second, make a thin mucilage by dissolving picked gum-acacia in warm water. Place the tissues in water for twelve hours, then put them in the mucilage overnight; remove and place in alcohol to precipitate the gum; hold between pieces of liver and carrot, and make sections. This method keeps the parts fairly well, which is of great advantage in the study of the development of the teeth. The disadvantage is that the sections must be placed in water to remove the gum before staining, with the consequent risk of displacing the parts. They can be mounted in glycerine, and studied without any other staining than that which they have received from the chromic acid. But I cannot recommend them, as they do *not* make good, permanent specimens.

Third, a new method of imbedding, introduced by Scheiferdecker, viz.—celloidin. Celloidin is a perfectly pure preparation of pyroxyline. I think the best method of preparing this mass is to make a saturated solution of celloidin, with equal parts of ether and alcohol. The decalcified specimen is first placed in equal parts of ether and alcohol for twenty-four hours, and then soaked for the *same* time in the celloidin, so as to thoroughly penetrate the tissue with the celloidin. Next, make a small paper box, in which place the specimen and cover with a thick celloidin solution; place under a bell-glass, raised slightly from the table, and leave overnight. The imbedding mass will shrink very considerably, for which allowance must be made in the size of the box and the quantity of mixture used. The shrinkage is due to

the evaporation of the alcohol and ether. When the mass is sufficiently hardened—which will require a longer or a shorter time, according to the size of the mass—place in a mixture of equal parts of alcohol and water to harden ; then remove from the paper box. Cut sections with a flat razor, dipped in methylated spirit or equal parts of alcohol and water, float sections off on the same fluid. Strong alcohol must not be used, as it softens the mass. The sections may be kept in a bottle filled with equal parts of alcohol and water until required for use. Having cut our sections, we are ready to stain and mount them.

If it is desired to mount in balsam and benzole—which I consider the best for permanent tooth preparations—either one of two methods may be used. First, the dehydrated stained specimen may be placed in a dish containing oil of cloves, and the celloidin removed, after which they may be mounted in the usual manner. Second, the unstained sections may be placed on the slide, on which there has previously been dropped a sufficient quantity of oil of cloves to fix, but not to float the section, after which it may be stained on the slide, dehydrated, and mounted in the usual way. The latter is especially applicable to very large, thin sections, as it obviates the necessity of re-handling. I believe that embryonal tissues do *not* permit of very elaborate and complicated staining methods. The brilliancy of the result depends on a combination of different tissues with their different chemical reactions. These are found only in matured tissues, especially in the lower order of animals. The best results I ever saw were some sections of the head of the newt and common snake.

To show teeth, only four stains are requisite, viz.—hæmatoxylin or logwood, eosin, picro-carmine, and methyl-green, valuable in the order named ; or as double-stains in combinations of hæmatoxylin and eosin, hæmatoxylin and picro-carmine, eosin and methyl-green, and picro-carmine and methyl-green. Double-stains give the best results. Tissues that have been hardened in chromic acid require to be placed in a 1 per cent. solution of carbonate of soda from fifteen to twenty minutes to remove the chromic acid.

To double-stain sections thus prepared with hæmatoxylin

and eosin, which is by far the best double-stain for general use, add 10 drops of hæmatoxylin to a watch-glass of distilled water, place the sections in it, and let them remain one or two minutes or until they assume a light straw colour. Thoroughly wash in ordinary water and place in the eosin stain. Dehydration and eosin-staining can both be accomplished at the same time; a matter of great importance, if you intend to mount in balsam. To do this keep on hand a saturated solution of eosin in absolute alcohol. When a stain is wanted, add a few drops of this solution to a watch-glass of ordinary alcohol. Having stained the tissues, rinse in absolute alcohol, and place on the slide; with a camel's-hair brush or pipette, drop several drops of oil of cloves on the section. Set aside and allow to clear, which will require several minutes. Examine, from time to time, under the microscope without placing the cover-glass, taking care not to let the objective touch the oil. When sufficiently clear, remove the surplus oil of cloves, and drop on the section sufficient balsam, thinned with chloroform, to cover the section; then place the cover-glass and put aside for the balsam to harden.

For the double staining, place several sections in a $\frac{1}{2}$ per cent. solution of picro-carmine, made after the following formula (Frey):—Carmine 1 gramme (about 15 grs.), liquor-ammonia 4 c.cm., aqua, 200 grammes. Mix and add 5 grammes picric-acid; shake thoroughly. After settling, draw off so as to leave the undissolved picric-acid behind. Evaporate in a shallow dish in the open air. A red powder is thus obtained, with which $\frac{1}{2}$ per cent. solution with distilled water is to be made, and allowed to stand several days, when it can be filtered, and is ready for use. Sections should be allowed to remain in this solution at least twenty minutes. A longer time does not matter. When sufficiently stained, remove to a watch-glass of distilled water, which had previously been acidulated by adding a few drops of acetic acid; this brings out the colour and fixes it.

To double-stain these sections with hæmatoxylin, place in dilute hæmatoxylin for a few minutes; wash in water, dehydrate in alcohol, place on side, clear with oil of cloves, and mount in balsam. To double-stain with methyl-green, take the sections previously stained in picro-carmine, and place them in

1 per cent. solution of methyl-green in alcohol and water (10 parts alcohol, 90 parts of water) for several minutes; this will over-stain. Next, place in absolute alcohol, which will remove the excess of green. When the right shade is procured, place on the slide, add oil of cloves to clear, and then mount. To double-stain with eosin and green, first stain with eosin, and then wash with water, to which has been added a few drops of hydrochloric acid; this fixes the stain. Then over-stain in green, decolourise in alcohol, place on a slide, add oil of cloves to clear, then mount. Having thus obtained, stained and mounted, a series of specimens, let us study them, and see what they will show, commencing with our smallest fœtal pig 2½ centimeters in length, of which we have made horizontal transparent sections of its inferior maxillæ. The first sections remove the surface of the gum, and simply show epithelial tissue; but a few sections deeper, we find a furrow or band filled with small round cells.

The outer sides of this band are composed of cylindrical cells. This band extends the entire length of the jaw; on either side of the band the jaw is made up of embryonal tissue, while on its labial and lingual aspect we find epithelium.

If osmic-acid solution be injected underneath the mucous-membrane of the mouth of a perfectly fresh 8 or 10 c.m. fœtal pig, and it then be immersed in a solution of equal parts of the same solution and alcohol to harden, the morphological changes in the cells of the enamel organ will be arrested. If we lift the mucous-membrane from its bed after the tissue is sufficiently hardened, the enamel organs will adhere and bring up with them their papillæ. You thus isolate the enamel organ from the surrounding calcified tissue, imbed and make sections, and these sections will show that what appears to be the recticulum of the stellate cells is in reality a broad mesh, the reticular appearance, with large interspace between, resulting from the shrinkage of the cells in the process of hardening with Müller's fluid, chromic acid, etc.—these latter failing to arrest the morphological changes. In the meshes of the stellate, also prepared by the osmic acid method, which has stained the cells a very dark brown, are seen numerous minute granular bodies, which have a high refractive power. If a few drops of dilute nitric acid be put on the slide

near the edge of the cover-glass and allowed to run under, these granular bodies will disappear, and at the same time large numbers of bubbles accumulate, and force themselves out from under the cover-glass. In this experiment, we have a positive demonstration of the presence of carbonate of lime in the meshes of the stellate cells of the fully-developed enamel organ previous to the beginning of the process of calcification of the enamel.

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Discovery by Observation.—The circumstances attending an archæological discovery recently made in German Altenburg, on the Danube, illustrate in the most striking manner the value of intelligent observation.

Professor Hauser was interested for a month in watching the colours of an extensive corn-field, which varied in every part. He found an elevated post of observation, and, after a week's close attention, declared it to be his opinion that the corn was growing over the site of an ancient amphitheatre. His drawings showed that the oblong centre piece was somewhat concave, and the corn was quite ripe in that part, because there was much soil between the surface and the bottom of the theatre. Elliptical lines of green, growing paler the higher they rose, showed the seats; and lines forming a radius from the centre showed the walls supporting the elliptical rows of seats. Excavations were made as soon as the corn had been harvested, which confirmed the professor's theory in nearly every particular. At six inches below the soil the top of the outer wall was found, and from there the soil gradually grew thicker until the bottom of the arena was reached, the pavement of which is in perfect condition. From the theatre a paved road leads to the Camp of Carnuntum.

Curious Problems in the Struggle for Life.

By Mrs. Alice Bodington.

THE immunity of some animals from the evil effects of bacterial and other poisons fatal to others is one of the most obscure problems in biology. Many interesting instances have been given by Dr. Clifford Allbutt, in his address before the British Medical Association at Glasgow. Many years ago, Darwin mentioned the curious fact that black pigs in Florida are unaffected by feeding on blood-root, which has the property of giving a red colouring to the bones; whilst white pigs are fatally injured. White pigs also suffer from eating buckwheat, on which black pigs thrive.

Pasteur relates that Cochin-China fowls resist chicken cholera, and that the field-mouse resists the septicæmia, so fatal to the house-mouse. Koch finds that the normal blood of the latter forms crystals with difficulty, whereas that of the field-mouse gives crystals readily. It is hardly to be supposed, however, that these latter facts have anything to do with the immunity of the field-mouse; possibly, his wild habits have given him a stronger constitution. The delicacy of white animals may be the effect of higher or more artificial cultivation. It is well known that new sorts of potatoes are at first disease-proof, but in ten or twelve years these varieties, though apparently healthy, lose their immunity, and new seedlings have to be raised. New species of vines introduced into a district are proof at first against the attacks of the phylloxera. This immunity of new species has enabled the inhabitants of Madeira to make their island a vine-growing district again. White-cocooned silkworms resist the disease which destroys the yellow. Algerian sheep are not subject to anthrax. Cattle and swine are very subject to pearl-evil, while the goats which graze beside them escape. The dog is almost insusceptible to glanders; while the ass and the guinea-pig, belonging to most widely different orders of animals, escape. Leprosy is absolutely incommunicable to any animal except man. Peptones, which prevent the coagulation of the blood in carni-

vora, have not that power over herbivora. Cattle in marsh-lands seem indifferent to the marsh-poison, and so do dogs; but individuals of the same species, if newly brought into the district, become infected. An analogous case occurred last year in France, where a Parisian family, going into a provincial district, were warned not to drink the water from a certain well. The well was innocuous to the inhabitants of the village, but "gave fever to strangers." The Parisian visitors were careful to avoid the water during their stay, but on the last morning, thinking possibly that "only once" wouldn't matter, they drank water from the affected well, and on their return to Paris all suffered more or less from typhoid fever.

A most strange case is that of the tsetse fly of South Africa, which is only fatal to domestic animals, such as the domestic ox, horse, and dog, while the buffalo and the zebra, bitten at the same time, remain unharmed. Man is bitten, but does not suffer. Neither do dogs reared wholly on game, but if fed on milk they die. Yet all young sucking animals are safe so long as they suck only! Inoculation is no defence, nor any length of life in the district. The resistance in the negro races to yellow fever is well known, whether they are inland or coast-bred, and is transmitted by them to their mixed progeny. On the other hand, the poison of veri-veri does not attack Europeans until they have lived in the district for some time; but they finally become liable to attack. But for all Aryans—Europeans and Hindus, branches of a race which have been widely separated since before the earliest historical period—the death-rate from veri-veri is low. For Chinese the average death-rate is 51·9, whilst for the European it is 28·6, and for the Hindu 27·8.

It is rather startling to find that the superior vitality of black pigs has a parallel in the superior vitality of the darker races of man in many parts of Western Europe. The aboriginal mongoloid race of Europe was in all probability easily conquered by force of arms, and in many districts almost exterminated, by the Aryan immigrants, whether these latter came originally from the north or from the east. But the proportion of dark-eyed, dark-haired persons is steadily increasing in Germany—so steadily, indeed, that it is doubtful whether the golden-haired, blue-eyed

Teutonic type will be found a few hundred years hence. In Wales, not only is there the dark, broad-headed, Celtic type—a race of vigorous vitality and high reproductive power—but there is also "a Mongoloid type, generally dark, mixed with a long-headed Basque type, and it is the dark races, as a whole, which give their special race-characters to the Welsh." The same dark-race mixture is also found in Ireland, sturdily surviving, not only the most hideous and ferocious struggles amongst themselves, but also the utmost evils which the exasperation of a conquering race could inflict upon them. And with this result, horrible to Elizabethan statesmen, that the English colonists in time became assimilated to the "mere, wild Irish," adapted their habits and modes of thought, and sank to nearly the same level.

Dr. Beddoe, of Bristol, and Dr. Davies, of Aberceri, agree as to the startling fact that there is a "difficulty in rearing fine, well-developed, fair children in towns, especially in the lower ranks." Dr. Davies adds:—"The Welsh Basque element is increasing in the west of England by a slight natural selection. In Bristol, mixed parents often have one child of a fair Saxon and another of a dark Basque type, and *the chances of survival of the dark child are better than those of the fair one.* Spasmodic croup and other convulsive diseases, or chest affections, will often kill the latter and leave the former. Even in the well-to-do classes, it is a comparatively difficult thing in Bristol to rear a well-developed fair child." Dr. Davies, having been Medical Officer of Health in Bristol, has had a large field of observation.

In Lower Canada, the French Canadians, the most unprogressive of Celts, are pushing aside the Canadians of Scotch and English descent by sheer animal vitality and reproductive power, sixteen children in a family being by no means an uncommon number amongst the "habitants."

The purity of the fair Aryan type—the "*sangre azul*" or "blue blood"—was jealously preserved by the descendants of the Visigoth conquerors of Spain, and strikes one notably in the portraits of Charles V. by Rubens. But the race was only kept pure by ruinous interbreeding. It deteriorated, both in body and mind, so that a vivacious French ambassadress of the 18th century said, that when a "grandee of Spain" was presented to

her, she expected to "see a thing like a monkey," pitifully degenerate, worse than a toy terrier or a Chinese pug-dog! The peasantry of Spain, on the contrary, are a race full of fine qualities, though, as might be expected, they are extremely conservative and unprogressive; probably, the finest Celtic race to be found in the world, with the exception of our own Scotch Highlanders.

The curious facts as to the immunities of certain races or certain animals from disease form only a portion of the various lines of interesting research pointed out by Dr. Clifford Allbutt to pioneer workers. The whole article will richly repay perusal, especially by those interested in organic chemistry, that fascinating, though infinitely difficult science, which promises to reveal the great secret of secrets—the Nature and Origin of Life.

To Prepare Sections of Spines of Echinus for Micro. Slides.

Mr. Hyatt described to the members of the New York Micro. Society his method of preparing sections of spines of *Echinus*, saying that it is much easier to grind down a number of such sections at one time than to grind one singly. He fills a glass tube with spines, cementing them in place with balsam, and then by means of a circular diamond-saw slices both tube and contained spines into thin discs. A number of these discs are cemented by balsam to a glass slip, and all are ground down together. In order to successfully turn them over to continue the grinding, they are cemented to the first slip with thin balsam. The slip to which they are to be transferred is supplied with thick balsam and inverted over the sections, whereupon, with proper manipulation, the sections will leave the first slip and adhere to the second. He mounts seven or eight sections of spines under one cover, returning them to their desired positions, if displaced in mounting, by inserting under the cover a needle ground flat and very thin upon an emery-wheel.

A Fly's Eye.*

By H. M. J. Underhill.

Plates XIV. and XV.

EVER since I first began to work with the microscope, when I was a boy, a fly's eye has always been to me a fascinating subject for study, both from the interest of its structure and from the difficulty of preparing specimens. In those days my ambition was to mount the part usually called the *cornea*, which is the outer skin, consisting of lenses, in such a way as to see in it, when I looked through my microscope, some hundreds of images of any little thing held beneath it—one image in each lens of the *cornea*. This I have never succeeded in doing, although I have met with preparations in which I could see such an appearance; and to behold some tiny object, a watch-key for example, multiplied indefinitely, is really a very curious sight. The book whence

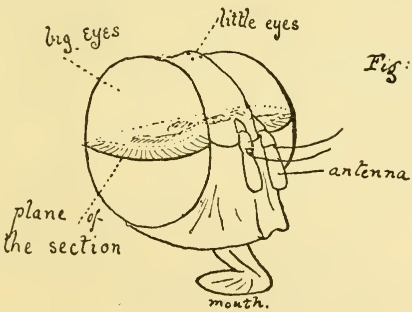


Fig: 1

Outline of a fly's head, showing in perspective the plane of the sections into which the eyes are cut, slightly enlarged.

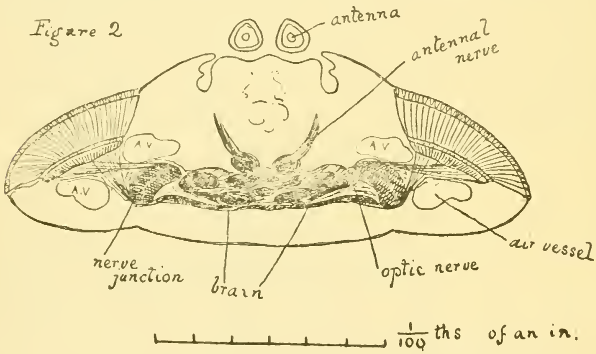
I then derived my information about setting up specimens, "Hogg on the Microscope," directs one to cut out "the eye" very carefully, and with a stiff camel's hair brush to scrape out "the red pigment behind it," so as to clean it for microscopical examination. What barbarity! The "red pigment" in question *is* "the eye," and very wonderful indeed it is. Its structure can only be made out when it is cut into very thin slices. This is an

* From *The Welcome.*

exceedingly difficult process, and it is only lately, after many trials and failures, that I have succeeded in getting sections which make some approach towards perfection.

In lowly organised animals there are often what are called "eye-spots." These are sensitive to light, but the animals cannot *see* with them, because there is no lens above them to form an optical image. All eyes that see have a lens to form an image and a substance sensitive to light placed in its focus, like the lens and sensitive plate of a photographic camera. This is a thing that "every schoolboy knows." What is not so well known is that the lens is generally a doublet; *i.e.*, two lenses, one behind the other. The *cornea*, usually only thought of as a protective covering, is in the higher animals just as much a lens as the

Figure 2

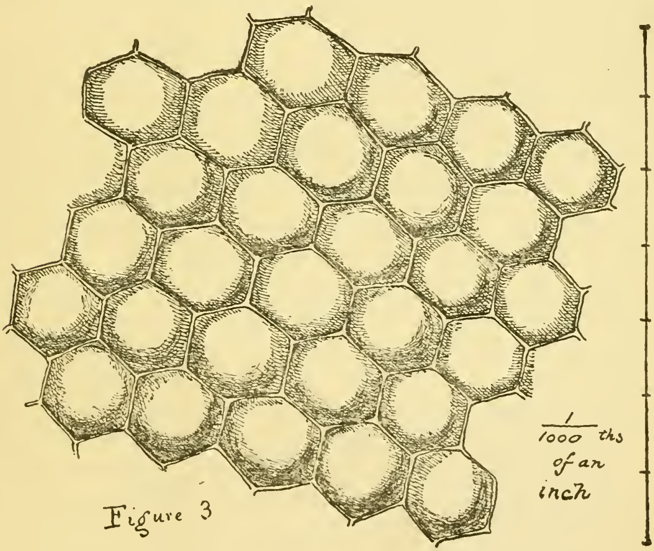


Single slice or section of a fly's head, showing brain, eyes, etc., magnified 20 diameters.

double convex *crystalline lens* behind it. The function of this crystalline lens is to accommodate the focus of the combined lenses to the distance of the object looked at, by the power the animal possesses of altering the convexity of the surfaces of the lens through muscular action. One would hardly expect to find such complicated mechanism in insects; yet their eyes too have "doublet lenses," although the hinder one has no power of altering its focus. In insects the *cornea* is obviously a lens—or perhaps I should say "lenses," since there are thousands of them in some species. But the crystalline lens is so modified that in a blow-

fly it is difficult to recognise it as a lens at all. By an examination, however, of the corresponding organs in animals nearly allied to insects, I think that its identity with the crystalline lens of higher animals may be recognised.

It will be convenient, before going further, to describe an insect's eye more particularly, taking that of the common blue-bottle, or blow-fly, for our example. A blow-fly has two big eyes and three little ones. Figure 1 is a rough outline of a blow-fly's head, showing this. The figure also attempts to explain the place where and the direction in which the head is cut into slices, to study the structure of the eye. Fig. 2 is one of such slices from



Small portion of the *cornea* of a fly's eye, showing the lenses. Magnified 400 diameters.

the place marked in Fig. 1, and Fig. 4 is a slice or section of a single big eye more highly magnified. This last figure shows how each of the big eyes is "compound"—*i.e.*, made up of a large number of tiny eyelets. I reckon their number at between 1,000 and 1,500 in each eye. Very exaggerated estimates are often given, yet in the eye of a large dragon-fly there must indeed be

several thousand eyelets. In a house-fly, however, the number probably does not reach one thousand.

The outer surface of each eye is the *cornea* before spoken of. It is, of course, merely the skin, specially modified into lenses. These, shown in Figs. 4 and 5, *l*, are double-convex, and the curves are of perfect symmetry. In many insects the lenses are plano-convex, the flat surface being sometimes outside, as in the Water-boatman, and in other cases inside, as in butterflies. In outline they are hexagonal, but the hexagons are by no means perfect, as may be seen in Fig. 3. Immediately beneath the lenses are little structures called, from their shape, the *cones*, Figs. 4 and 5, *co*. These, according to my idea, are the modified crystalline lenses of higher animals.

In certain small Crustacea, a class nearly allied to the Insecta, in the order Entomostraca, the eye is wholly within the body of the animal. In a marine species that I have, it makes no show externally, but the shell is so transparent as to be no obstacle to vision. There is, therefore, no *cornea* to the eye, properly speaking. But the *cones*, so conspicuous in an insect's eye, are there: and the *cones*, one can see, are themselves lenses. This fact is even plainer in a rather more highly organised Entomostracon called *Leptodora*, where the eye is nearer the surface of the body in a point projecting from the head, and yet the part corresponding to the cornea is not facetted. Going a stage higher, to the freshwater shrimp, *Gammarus*, we find that the eyes come up close to the skin; that the cornea is facetted; but that it is apparently not made into lenses, its two surfaces being parallel. The *cones* beneath it, identical with the *cones* in an insect's eye, are still plainly lenses, for they are solid and highly refractive of light. If a series of insects be examined, it will be found that some, butterflies and moths for instance, have *solid* cones, while others, such as flies, have them *hollow*. The solid cones refract light just as in the shrimps, and they must therefore be lenses. I may also say that in caterpillars, which have simple eyes, while the cornea is itself lens-shaped, there is a globular crystalline lens immediately beneath it. So the fact that the facets of the cornea of an insect's eye are shaped like and act as lenses, is no argument against there being other lenses immediately beneath them. The

hollow cones of the blow-fly are filled with a watery or albuminous fluid. This would not refract light very much; so, possibly, they are hardly lenses.

Thus far, then, I think our understanding of a fly's eye is clear—we find a series of lenses (the *cornea*), each forming an optical image, and a corresponding set of modified crystalline lenses beneath them. The focus of this doublet lens falls just at the point of the "cone" (see Fig. 5). So here we ought to look for the sensitive plate, or portion of the eye which receives the picture. It is not a plate, but a little knob, the end of a nerve fibre, and close round it we find cell structure which comparative anatomy tells us must be of a highly sensitive nature. In a very little space there is quite a crowd of *nuclei*, and the nucleus is the living, the most active part of a cell. Each cone is surrounded by opaque pigment, generally burnt-sienna-coloured, in flies, and at the points of the cones are rings of brighter pigment, the colour of which is sometimes brilliant crimson (*p.l.*, Fig. 4, and *pg.c.*, Fig. 5). Now there are nuclei in the pigment surrounding the cone, nuclei in the rings of pigment at the point of the cone, nuclei round the little knob, and nuclei again round the "rod" of which the knob is the termination; n^1, n^2, n^3, n^4, Fig. 5. Such a part must therefore be extremely sensitive, and the presence of the pigment is said to show that the structure is sensitive to light; for, I am told, without the opaque pigment light would pass through the transparent nerve fibre without affecting it. At these points, therefore, are formed optical images on sensitive tissue, one image by every lens. Our own two eyes give us two images; the two eyes of a fly give it some two or three thousand images. By the power we possess of moving our eyes we are able to make their two images overlap, so that we only perceive one. For the eyes of a fly to be useful, it is clear that it must possess some means of combining the multitude of images into one perception, and this means is supplied by the peculiar structure of the retina.

Immediately beneath the *cones* in a fly's eye stands a series of *rods*, fitting to them by the knobs before mentioned. (I may remark that it is very unfortunate for these structures to have been called "rods and cones," because the name tends to confound them with the "rods and cones" of a mammalian retina.

The *rods* alone of a fly's eye, I am inclined to think, may correspond to the "rods and cones" of the mammalian eye, but the insect's *cones* most certainly have nothing to do with them, for they are, as I consider, a modification of the crystalline lenses.) These *rods* of a fly's eye are made up of a central nerve fibre, surrounded by finer fibres, the whole being in a sheath, like a telegraph cable. They are considered to be true "nerve-end cells;" *i.e.*, the portion of the nerve that receives a sensation. Fig. 4, *r.r*, shows a set taken across the eye, and Fig. 5 *r*, gives a single one more highly magnified. They stand on a thin membrane pierced with many holes (m^1, Figs. 4 and 5), a hole for each rod, and a hole for each one of numerous air-vessels, of which I will speak directly. Passing through the membrane, the rods change into an ordinary nerve-fibre (*nv.*, Fig. 5; see also Fig. 4). After a short distance, each fibre swells into a cell-like body, and these bodies make altogether a kind of nerve-junction or ganglion (*n.j.* 1, Figs. 4 and 5), which stands on a second membrane, m^2. Immediately above the ganglion is a layer of nerve cells with very large nuclei, between which the fibres pass. Contracting again, as they emerge from the underside of this ganglion, the nervelets become very thin; they run quite straight, and those from the *hinder* side of the eye cross over to the *front* side (Figs. 2 and 4). When they have crossed, they enter a mass of small nerve cells, and, each individual nervelet swelling again, form a second ganglion, something like the first (*n. j.*, 2). The nervelets issue from this nerve-junction as fibres once more, and collect together to form the optic nerve, which finally loses itself in the brain (Fig. 4, *op. n.*)

To describe all this is easy; to say what is the function of each part is very difficult; and it is indeed impossible to affirm specifically, "this part does this, and the other part performs that." Yet I have no doubt that the unusual complexity of this retina is for the purpose of combining the thousand and one images formed by the lenses, for insects with simple eyes, spiders and caterpillars to wit, have not such a complicated retina. Besides nerves, a fly's eye is full of *air-vessels.* Some, shaped like thin French beans, stand up between the *rods*, springing from a matted layer of them which lies just below the first membrane (*av*, *av*, Figs. 4

and 5). In addition to this, the whole eye is surrounded by very large air-vessels (*A V*, *A V*, Figs. 2 and 4). I have examined a living may-fly grub—an insect with a very transparent skin—and I see that where these large air-vessels are, there is a broad stream of blood running into or round the eye. Insects have no blood-vessels, but the blood follows the course of the air-vessels. These penetrate the whole body, and the blood runs outside them. For any nerve to feel, it is necessary that a supply of fresh blood and fresh air should constantly be applied to it. The air-vessels between the rods, and the matted layer of them lying immediately above the first nerve-junction, are necessary to keep these two extremely sensitive parts of the retina in working order. Their very presence, indeed, helps us to understand how sensitive these parts are. The second nerve-junction has fine air-vessels running into it.

Bearing all this in mind, I would suggest that, in the first nerve-junction, there is, as it were, a preliminary combining of the images; that the crossing of the nervelets and the second nerve-junction completes the process; and that the gathering of all the much elaborated nervelets into one bundle of simple fibres after the second nerve-junction (*op. n.*, Fig. 4) truly indicates that the multitude of sensations has now been turned into one perception. Yet I do not think that a fly sees with all its eyelets at once. We ourselves only perceive distinctly at any one moment the very small space represented by a disc half an inch in diameter held about one foot from the eye. We think that we have distinct vision over a larger surface than this, because we can shift the direction of our eyes so instantaneously; but it is not so. Whether or not a fly can see distinctly out of only one eyelet at a time, I cannot tell. Probably it can only, like ourselves, see distinctly what it looks at and attends to, and that for this, as we may say, it "looks out of" only one, or some small number of eyelets at a time. So that the large number of eyelets, each one capable of forming a complete picture, is to supply the place of the power to move its eyes, the eyelets looking in every direction, except behind the head. And although each eyelet forms a complete picture, it is not a picture of the fly's whole field of vision, but only of that small part of it in a line with the axis of

the lens of the eyelet. And these little pictures fit together in the fly's perception like the little cubes of a mosaic picture, forming a continuous whole.

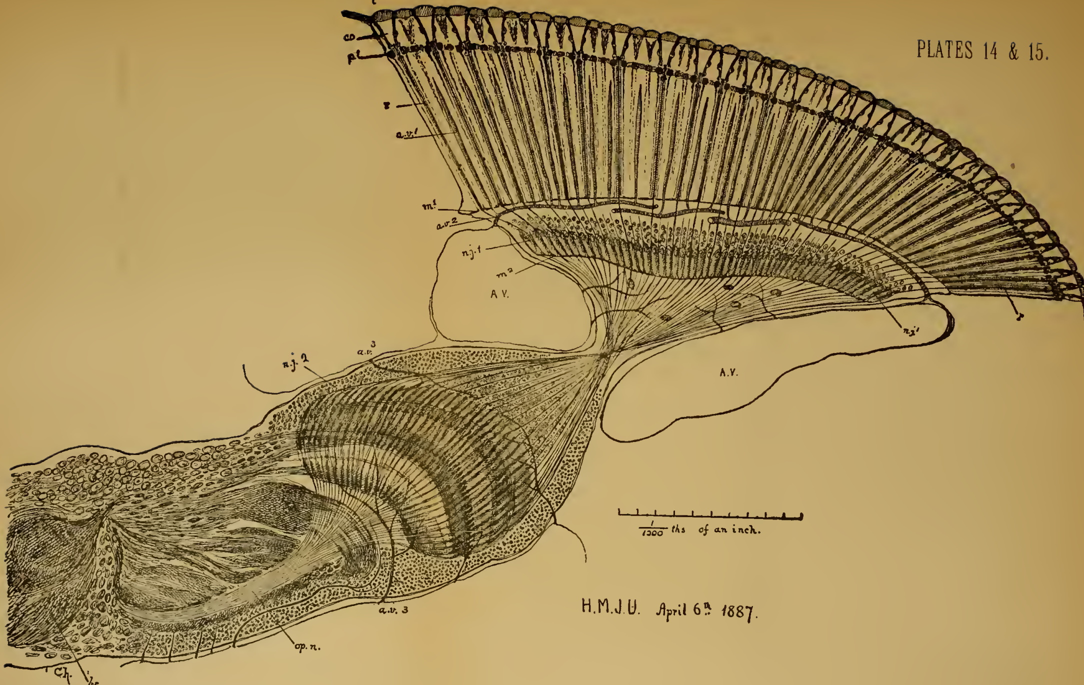
An illustration, which I think is true as far as it goes, may help to explain to some extent how vision takes place. Supposing nervous action to be something like electric action, the pictures from the lenses, falling on the knobs of the rods, are like the message rapped into his machine by the telegraphic operator; the nerve-fibres are like the telegraph wires; and the nerve-junctions are the galvanic batteries which alone render the transmission of a current possible, and perceptible by the receiver at the other end:—the "other end" in the fly being its brain. Here we are brought up to the problem how nervous action becomes "states of consciousness," and as that problem is insolvable, here we must stop.

To sum up: a fly's eye consists of many eyelets; each eyelet has a lens to form a picture, and a sensitive knob on which the picture falls; the many pictures of the compound retina are transmitted by fibres through two nerve-junctions to the brain; and, in the course of their passage, they are combined into one perception. One or two observations of a fly's habits will bring this paper to a fitting close. Flies are decidedly short-sighted—for they do not perceive you until you get within a few yards of them. They probably have some perception of colour as well as of form, for, when seeking honey for food, they alight with certainty on a flower rather than on a leaf. Their sense of smell, however, which is certainly acute, doubtless helps their sight in this point. Yet their eyes as a whole show us that the faculty of sight, always wonderful, is very wonderful indeed in our too familiar friend, the Blow-fly.

EXPLANATION OF PLATES XIV. AND XV.

Fig. 4.—Section of a fly's eye:—*l.*, lenses; *co.*, cones; *pt.*, pigment layers, consisting of rings round the rods; *r.r.*, rods; *a.v.* 1, air-vessels between the rods; *m.* 1, membrane on which the rods and air-vessels stand; *a.v.* 2, short lengths of air-vessels, which form a matted layer above the first nerve-junction; *n.j.* 1, first nerve-junction; *m.* 2, membrane on which it stands; *A.V.*, *A.V.*, large air-vessels around the eye; *n.j.* 2, second nerve-junction; *a.v.* 3, air-vessels; *op.n.*, optic nerve; *br.*, brain; × 160 diameters.

,, 5.—Single eyelet of a fly. The lettering is the same as in Fig. 4, with the addition of *n.* 1, 2, 3, 4, nuclei; *pg.c.*, pigment-cells; *nv.*, nerve-fibres; and *nv.c.*, nerve-cells; × 600 diameters.



H.M.J.U. April 6th 1887.

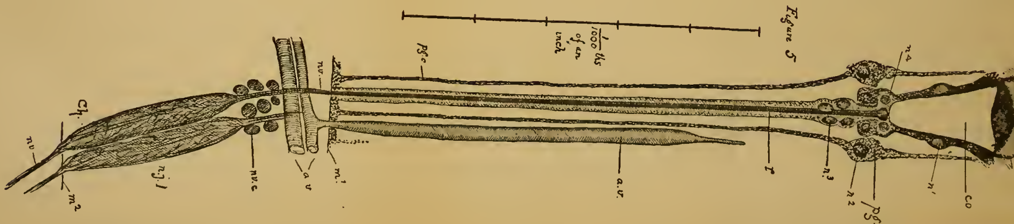


Figure 5

To Stain Tubercle Bacilli.

THE following is one which we (*National Druggist*, U.S.A.) have been using with great satisfaction for some time past, and as a good demonstration of the presence (or absence) of the bacilli can be made by it in from thirty to ninety seconds, we think that it leaves nothing to be desired on the score of rapidity. It is a modification of Neilsen's process, and is, if we remember correctly, the device of Dr. Glorieux. The fuchsin stain is identical with that of Neilsen, viz.—Fuchsin, 5 grains; absolute alcohol, 50 minims; carbolic acid in crystals, 20 grains; distilled water, enough to make 1 ounce.

Dissolve the carbolic acid in the distilled water and the fuchsin in the alcohol, and mix the solutions. Let stand with occasional agitation for eight or ten hours, and filter. The modification comes in in the bleaching and contrast staining. Instead of using a separate fluid for each, Glorieux has devised an acid solution of methyl blue, which performs both functions at once and in the most perfect manner. It is made as follows:—Take of sulphuric acid (chemically pure, specific gravity, 1·85) 65 minims; absolute alcohol, 100 minims; distilled water, sufficient to make 1 fluid ounce. Mix the acid and water, let cool, and add the alcohol. Then add a little at a time, and with constant stirring; methyl blue to saturation. Let stand for several hours and filter. In use the cover is immersed in the fuchsin for a few seconds; rinse and drop into the acid blue stain, and leave for a similar length of time; rinse, dry, and mount as in other processes. The real cause of failure in making good, clear, permanent preparations lies, usually, not so much in the staining as in the preliminary preparation and manipulation of the sputum or other material. Most physicians—especially those who believe that the minutiæ and details insisted on by practical microscopists are "useless technicalities," adapted to make "microscopy as burdensome and troublesome as possible"—think that if they smear the crude sputum on the cover-glass, and pass it through the flame of a lamp a few times, they have prepared the material for staining, and are disappointed if they do not get good results. Biedert's

method of manipulation is that preferred by me. It is as follows :– Mix the sputum with double its volume of water, and add to each tablespoonful of the mixture 5 minims of liquor sodæ or potassæ (preferably the former). Boil until perfectly fluid, and then add an equal volume of water and boil again. Let stand for a couple of days, and then pour off the clear supernatant fluid. Add a little fresh egg albumen to the residue; mix and prepare the cover-glasses with the mixture. Thus prepared, you will have a mount of tubercle bacilli that will surprise you—not only as to the quantity of bacilli, but as to the sharpness and clearness of staining.

Some Fragments of Weed from a Pond, and their Tenants.

By J. C. Webb.

When we gathered our fragments of weed, we placed them in a glass jar with some of the pond water in which they had grown, and on making a careful examination with the aid of a small hand-lens, we quickly discover adhering to them specimens of the Hydra, Melicerta ringens, Stephanoceros, and Vorticelli; whilst darting about amongst other animalculæ we notice several rather lively specimens of the Water-Flea. Each of these creatures has a history which cannot fail to awaken interest in the mind of the merest novice in natural history, especially after looking at the objects themselves through a microscope. Let us, then, place our pieces of weed in a suitable glass trough, and have a glance at the specimens they contain.

Our first specimen, the Hydra, belongs to the Zoophyte family, so named from their resemblance to plants. It is a small, tubular body, attached at one end to the water-weed, with an open mouth, surrounded by long tentacles at the other. It is exceedingly contractile, and capable of many changes of form. Sometimes it draws itself up into a shape resembling a button, while at others it may be seen stretched out to a marvellous length, the tentacula changing in length and diameter in a similar way.

The Hydra is a sensitive creature, as anyone can prove by touching it, and the purpose of this sensitiveness is easily discovered, for when a water-flea touches its outspread feelers, or tentacles, these organs will be observed to at once twine themselves round its body, and, after overcoming the victim, convey it to its mouth, down which it is rapidly drawn into the stomach. But what strikes us as the most remarkable is the suddenness with which the victim is rendered helpless; for so quickly do its struggles cease that we might well imagine it to have become paralysed.

When, however, we place a tentacle of the Hydra in a live-box under our microscope and gently press it, we discover the cause, for we observe numerous little thread-like darts shoot out from sundry cells embedded in the tissues, and from the way in which these cells burst on being irritated, we are at once led to the conclusion that each cell is a sort of poison apparatus, capable of paralysing the unfortunate victim into whose body the darts penetrate.*

But the most wonderful part of the history of the Hydra is that it can be cut in pieces, and each piece will grow into a perfect creature; while even if turned inside out like the finger of a glove, this strange animal suffers no apparent inconvenience, for it will eat and digest its food the same as if left in its normal condition.

The ordinary, and indeed natural, ways of increase in Hydra life are two: one by means of budding and the other by means of eggs. The former appears to be the method of increase during the summer and warmer months, and the latter during those colder periods of the year so fatal to the lower forms of animal life. Indeed, it is not uncommon to see a hydra with a young one growing from its side, which in its turn has budded and produced a miniature of itself, thus presenting three generations adhering together as a compound organism. Sooner or later, however, the young hydra—like precocious offspring—sever their connection with the parent body, and float away through the

* This is not established. The writer does not notice the fine threads which attach each dart to the body.—*Ed.*

water to seek a new resting-place and begin life on its own account.

Baker relates an interesting fact in regard to the voracity of the hydra, which it may not be out of place to quote. He says:—"Sometimes it happens that two polyps will seize upon the same worm, when a struggle for the prey ensues, in which the strongest, of course, gains the victory, or each polype begins quietly to swallow his portion, and continues to gulp down his half until the mouths of the pair approach and come at last into actual conflict." They then wait till the worm breaks in two, "when each obtains his share; but should the prey prove too tough, woe to the unready! The more resolute dilates its mouth to the requisite extent, and deliberately swallows its opponent, sometimes partially, so as, however, to compel the discharge of the bait, while at other times the weaker hydra is engulphed. But a polype is no fitting food for a polype, and his capacity of endurance saves him from the living tomb, for after a time, when the worm is sucked out of him, the sufferer is disgorged with no other loss than his dinner."

Melicerta ringens is one of the Rotifera, and is esteemed a great prize amongst most microscopists on account of the ingenuous way in which it constructs the tube it inhabits. This marvellous creature builds his mansion brick by brick, making his bricks as he goes on, from substances floating around him, and shaping them in the mould which he carries upon his body.

Looking at this strange creature under the microscope, we observe a tower composed of light, reddish-brown pellets; then suddenly from the top protrudes a complicated mass of transparent flesh, which slowly expands, disclosing two large, rounded discs, around which a wreath of cilia is seen in active motion. This is followed by two smaller leaflets, likewise surrounded with cilia. Between the lower leaves the gizzard is seen grinding away, and above it is an organ of which the eminent naturalist, Mr. Gosse, was the first to discover the use. This organ resembles the circular ventilators sometimes seen in kitchen-windows, and Mr. Gosse found that it was the machine for making the bricks of which the creature constructs its house. In order to obtain the materials for brick-making, the builder modifies the direction of

the ciliary currents in such a manner as to throw a stream of small particles into the mould, which is a muscular organ secreting a cement by which they are joined together. When a pellet is completed, the creature bends down its body and deposits it in its proper place, and this goes on day by day until the tower is finished and the creature dies.

This animal increases by means of eggs which are hatched in the tower. Soon after its birth, the young builder is thrown overboard, as it were. It then bears something of a resemblance to the common rotifer, and swims about rapidly as if rejoicing in its liberty. After a short time, however, it selects a suitable site for its future habitation, and then, having first constructed, as a temporary dwelling, a glass-like tube, commences the erection of its marvellous tower.

Our third object is the "Stephanoceros," or "crowned animalculæ." This exquisitely beautiful creature is about the thirty-sixth part of an inch in length. It is enclosed in a transparent tube, over which it extends its five long arms in a graceful manner. These arms, as will be seen, are furnished with rows of short cilia, which enable the creature to retain the prey brought within their grasp until it is swallowed. At the least danger these arms are withdrawn into the sheath. The body in our specimen resembles a crystal cup, and the food, composed of small red and green coloured bodies, adds to the lustre of this remarkable creature. Often an egg or two may be seen attached to the parent, and the young, when hatched, speedily settle down the same as in the previous instance. These animals are frequently to be found on some of the branches of small water-plants, and are capable of being preserved for some weeks if placed in a suitable tank with a proper supply of fresh water.

Let us now turn our attention to another species of animalculæ, Vorticelli, which is to be found in most country ponds, and not unfrequently in our aquariums. These creatures are of various sizes, some being so large that their presence can almost be detected with the naked eye, and others so minute as to require one of the high powers of our microscope to reveal all their structure. They bear a striking resemblance to a cup in form, and their bodies are placed upon a long stalk, which has the

power of contracting in a spiral fashion whenever anything happens to disturb them. In some species these stalks are branched, so that a large number of these creatures are found on a single stem, forming an exceedingly beautiful object under the microscope. Sometimes, when watching these compound Vorticella, their stalks will suddenly contract, and a large mass, expanding over the whole field of view, will disappear, and then as suddenly reappear in all their beauty.

If we examine these creatures minutely, we shall find that the mouths of the little cups are surrounded by cilia, which are in constant motion, and that each cup possesses two apertures, through one of which a current of water enters and from the other passes out. Not unfrequently, one of these small cups will break away from its stalk, and swim about in the water with remarkable rapidity, as if rejoicing in its freedom.

In common with many of the lower animals, these creatures have three ways of multiplying their race: one by the division of their bodies, another by buds (after the fashion of plants), and another by reproductive germs.

There are, doubtless, other interesting objects on our fragments of weed, if we had the time to examine them more closely, and the space at my disposal would permit; but as such is not the case, I will conclude by stating that the few particulars I have endeavoured to give are not intended to satisfy, but rather to excite curiosity, and induce those readers who are able, to seek further information on their own account.

Brownian Movements.

The President of the New York Microscopical Society informed the members at a recent meeting that the specimen of gamboge, rubbed up in water, which he had prepared Aug. 3rd, 1874, and which had until recently showed very active movements, seemed at last to have ceased its activity, a leak having developed in the enclosing cell, and evaporation having ensued in consequence. He thought the subject of interest, as 14 years was probably the longest period during which the phenomenon had been under observation.

On Cuscuta Gronovii.*

By Henrietta E. Hooker, Ph.D.

Plate 16.

FOR a parasite that is parasitic from its heart and with all its heart, after having tried an honest life, there is perhaps no better example than Dodder, which in our region (S. Hadley, Mass.) is *Cuscuta Gronovii.* We find it in abundance in autumn, early and late, twining its orange-coloured stems about grass, solidago, alder, and the like, with a glory of white, bell-shaped flowers, in cymose clusters, appearing as lateral buds in the axils of bracts.

In preparing for the study of Cuscuta, fresh plants were placed in alcohol, some were dried—as gathered on the host—and seeds were sowed in pots. From the first, imbedded in celloidin, slides were prepared. The dried specimens yielded knowledge of external parts and abundance of seeds, which were valuable in ways that will appear later. The seeds are exalbuminous, of comparatively large size, with a conspicuous hilum and hard testa; but the latter yielded readily to soaking in dilute potash, and careful dissecting removed the two coats and freed the coiled, snake-like embryo (Fig. 1). The root end of the embryo lies outermost, and is slightly enlarged, more noticeably so after germination, when it evidently remains, for some time, a store-house of nourishment.

The time required for germination was found to vary much. Some of the autumn-gathered seeds germinated in three days, after a few days' soaking; others, obtained from alder twigs out of doors, in February, and sowed dry, were three weeks in showing signs of life. The end of the stem which first emerged from the seed-coats was very soon covered with numerous short rhizoids, and careful observations failed to discover any trace of a root-cap. Figs. 2 and 3 illustrate seedling dodders. The tip produces, even at a very early stage, the rhizoids mentioned. Comparing Fig. 3 with Fig. 1, it will be seen that the root-hairs must have grown very rapidly, none being on the embryo, just

* From the *Botanical Gazette.*

before germination. Fig. 2 is the root end of a seedling 2 inches long, and hence the rhizoids are much further developed. Fig. 5 illustrates one of the most interesting things in my study of the plant, and one that I could not find mentioned by any observer, viz., a method by which the plant cut itself off from normal nutrition. Having reached some suitable host—a twig of *Forsythia viridissima* in this case—it twines around it like a tendril, by two or three coils, and in coiling contracts so as to draw itself nearer the host. This contraction, if the seedling is not too deeply rooted, or too slack between the soil and the support, pulls the roots from the earth and leaves the plant—a parasite by suicide—with roots at varying distances above the soil, ¼ of an inch being perhaps the highest I observed. If the plant is not uprooted in this manner or by the lengthening of the internode of the host to which it is attached, as sometimes happens, the lower part of the stem dies, and the connection is thus severed with the absorbing root, not, however, until the enlarged portion of the stem has been drained of its nourishment or the plant has reached some other supply. All the plants that germinated earliest, of those we studied, hung themselves; the later ones—those washed deeper into the soil—died at base. Our gardener, noticing the hanging ones, said, "Those are not plants; they crawl up sticks like an inch-worm." These germinating plants are white below, but yellowish-green at summit, suggesting that the dodder, even in its degeneracy, has some chlorophyll, and may elaborate food for a short time. The amount of nourishment stored in the embryo hardly seems sufficient to enable the seedling to produce such a length of stem before reaching a host, as is done by some. Other things, too, indicate ability to assimilate, such as the greenness of buds and branches, for some time after they appear. This colouring matter is removed by alcohol.

To illustrate the rapidity of growth after germination, I give the statistics of a single plant, grown in my own room under a bell-jar, in circumstances perhaps not the most favourable, as there was much variation in temperature, especially at night. The seeds were collected out of doors on some alder twigs, and sowed immediately, February 29. The first plantlet appeared at the surface of the soil, March 20, and twenty-four hours later, at

8 A.M., March 21, was one inch long, with tip doubled back and coiled once about itself like a whip upon its stalk. All was white but the coiled tip. At 10 A.M. it had more nearly uncoiled and had gained one-fourth inch in length in the two hours; at twelve it was erect and slightly elongated; at 6 P.M. its length was one and one-half inches and its inclination toward the nearest host. Measurement at 8 A.M, March 22, showed it to have gained three-fourths of an inch in twenty-four hours—one-third of that length between 8 and 10 A.M. Careful observation between the corresponding hours the second day showed the same gain, suggesting, what experiments with other seedlings seemed to corroborate, that 8 to 10 A.M. represented the maximum period of growth. The plantlet was then, at the height of two inches, touching its host. Contact caused it to coil like a tendril, although it was several times disturbed and shaken from its support, so that at 8 A.M., Saturday, the 24th, three days after germination, it was fast to its host with two close coils about the stem. Growth in length now ceased for several days, all its energy being expended in producing suckers and thrusting the haustoria into the host. March 26 the suckers were well developed, the root portion was brown and useless, the reservoir above the rhizoid portion exhausted of supplies, and the plant apparently in position for an easy life. During this time the nutation of the tip of the seedling was opposite to the course of the sun.

From observation upon this and other plants it was evident that there is a limit to the size of stem they are able to encircle, and that the diameter must be small. One that I noticed attempting to surround a large geranium stem was unequal to the task, and coiled back upon itself twice upon the side of the trunk. Plants showed very little discrimination in the selection of hosts, attacking everything that offered support—dead and dying stems, as well as fresh ones, and even the rim of the flower-pot. They usually recoiled after one turn about a dead twig, and extended the tip further unless the root had been lifted from the soil. When a suitable host was obtained, the tip nestled down close to it and did not attempt further wandering.

We failed, for a long time, in all our attempts to cultivate the

dodder—further than to obtain a few coils about the stem. We never suspected the unsuitable character of the hosts, as out-door dodders do not seem particular. But an enterprising seedling taught us the lesson by seizing a young geranium petiole, just emerging from the bud, and beginning to grow by feet in the same pot where a Eupatorium-entertained companion, of the same age, grew scaly, stubby, and by inches, and all others died. After this there was no difficulty in raising dodders.

The suckers are, outwardly, enlarged fleshy discs, which the parasite forms and presses hard against the host, sending into it from their centre, filamentous organs called haustoria, by which they absorb the elaborated juices as roots take moisture from the soil. They differ from true roots, as does the root-acting end of the stem, in the absence of a root-cap.

An attempt to remove the dodder from a stem to which it is well attached often ends in taking with it at least the cortex of the plant on which it grows. Sections either longitudinal or vertical through the parasite, in position on its host, median as regards a sucker, will explain this. Each sucker starts, as does a root, in the vascular tissue of the stem, and is a cylinder, sharpened like a blunt pencil, where it enters the host and enlarges immediately afterward. Thus is made a sort of neck about which the epidermis of both host and parasite fit very nearly; the sudden enlargement of the latter, in its new quarters, serving, as does a nut on a bolt, to prevent its easy removal.

The suckers, in their origin, are domes of meristem tissue before they reach the epidermis. Whatever lack of discernment the dodder may show in its selection of a host, once well placed, it lives up to its opportunities. It may, and usually does, in a woody stem like that of Solidago, send one root into the centre, as if for deep anchorage, but spreads out by far the larger portion of its absorbing tissue in the cambium and sieve-tube regions, where elaborated material is most abundant. Its tissue is easily distinguished from that of the host by its enlarged thin-walled cells with prominent nuclei. When the cutting was exactly median, the tissue seemed like a compact cylinder made up of filaments of cells, end to end, like meristem tissue, which branched, however, in a variety of ways inside the host. When growing on hollow

stems like grasses, as it was common to find them, the haustorium scarcely branched, there being little opportunity.

One of the most singular phases of dodder life was a sort of self-grafting or self-parasitism. With a low power it was difficult to distinguish which was host and which guest, as the haustorium extended from the vascular region of one stem to the same of another. In examining the alcoholic specimens, I found this common, and it has often been repeated on those growing in my own room, usually under such circumstances as these: If a parasite had occasion to twine about an already thickly covered host, in its anxiety to obtain its share of elaborated material, it was willing to take a sort of second mortgage upon it, after it had passed into the tissues of the first; this inter-parasitism also occurs frequently when for a long distance stems intertwine.

There is little differentiation in the tissues of the dodder; it needs, very early, conducting tissue for carrying moisture through the stem to the rapidly growing and probably assimilating apex. To meet this need, vascular tissue is found as soon as germination takes place. It is very simple, consisting of alternate stripes of tracheids and parenchyma, each about two rows of cells broad, and in the best developed stems occupies perhaps from one-third to one-half the diameter. It is well adapted for twining by this alternation with the softer parts, while the predominance of the latter favours the carrying of elaborated material, as it is in these such products travel. Iodine testifies to the presence of starch in the tissues of mature plants. Other re-agents show, as do the markings on the walls, the woody nature of the alternate bands evident in a section of stem.

Of the adventitious buds, known to be abundant in the dodders, I have studied only those producing branches.

Their origin was in this manner: When a parasitic root had become well established, so that the plant was thoroughly engrafted upon the host, in an axil thus formed, a branch would arise, after the manner of an axillary branch on a normal plant. The regular branching of a stem of Cuscuta is unusual in the centrifugally arrangeda ccessory buds (Figs. 6 and 7), the last-formed bud being farthest from the parent stem, though sections show it to originate in the axil bundle.

The epidermis of dodder varies with its position. On the long internodes between adjacent scales stomata are rare, while over suckers—*i.e.*, on the side of the stem opposite them—very small stomata are quite abundant. This explains, in a measure, the continuance of life and growth for two weeks or more in branches cut from the parent stem and suspended in the air, though such stems never form coils or suckers.

Each flower has a short pedicel like the main stem in structure, a thickened receptacle, a five-lobed calyx and corolla with beautifully branched fringes lining the latter, and adherent stamens alternating with its lobes; the ovary has two cells with two ovules in a cell, and there are two knob-like stigmas on short styles. As to the manner of fertilisation of the dodder, whether self or cross fertilised, I have had no opportunity to observe.

The two-celled ovary is composed of two carpellary leaves, with two cushion-like basal placentæ, each bearing two ovules, though at maturity there is often but one. The sections of placentæ are deceptive when the ovules are absent, having much the appearance of young ovules. The study of the ovules with reference to the layers in the seed coat gives evidence that in the mature testa there are three. The outer is quite unlike the two below, which are, perhaps, divisions of the same cell layer. They probably arise and cover the nucellus in an early stage, but are not differentiated into the mature form until a late period in the maturity of the ovule.

A short distance below the apex of each mature embryo, and always on the inside of the curve, as it lies coiled in the seed, is a well-developed scale (Figs. 8 and 9, *a*). Another scale almost as well developed is usually to be found slightly below the apex of the embryo, but on the outer side of the curve (Figs. 8 and 9, *b*). These two are separated by quite a portion of the stem in length, and in some cases the second scale is only partially differentiated, and yet a part of the tip, whose tissues, under a high power, are evidently of scales in process of formation. In no case were the scales opposite, or approximating it, as a pair of cotyledons would stand. What may be their relation to the embryo, I do not know, but the apex, with its forming scales, of which this second one is sometimes a part, could well be a plumule. Comparing

Custata Grenacri

seedlings two inches in height with the embryos, the scales were evident (at least always the inner one), and at a distance from the growing tip corresponding to the increased length of the plant. They in every case soon turned brown.

How the dodder became a parasite is an interesting theme, and pleasantly treated in an article in the *Popular Science Monthly*, Vol. XXV. A weak stem, desire to reach the light, twining to accomplish this, and tasting juices by chance, they were nourished by them and given a tendency which increased in favourably situated descendants until, as Drummond states : " Henceforth to the botanist the adult dodder presents the degraded spectacle of a plant without a root, without a twig, without a leaf, and having a stem so useless as to be inadequate to bear its own weight." So it stands a monument of degeneration. Other plants with smaller beginnings have gone on to higher forms, while the dodder, as Prof. Drummond again, in substance, says, from a breach of the laws of evolution, pays one of Nature's heaviest fines—loses the organs it once had.

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EXPLANATION OF PLATE XVI.

Fig. 1, mature embryo, dissected from seed. Fig. 2, tip of root of *a*, Fig. 5. Fig. 3, enlarged view of 4, an embryo one-half nat. size, just escaped from seed coats. Fig. 5, seedlings, one-half nat. size. Figs. 6 and 7, accessory branching. Figs. 8 and 9, tips of embryos, enlarged : *a*, inner, lower scale ; *b*, outer scale.

We learn from *Nature* that the Executive Committee of the International Exhibition of Geographical, Commercial, and Industrial Botany, to be held at Antwerp in 1890, has decided to celebrate on this occasion the three hundredth anniversary of the Invention of the Microscope. It proposes to organise what it calls a "retrospective exhibition of the microscope and an exhibition of instruments produced by living makers." Conferences relating to all important questions connected with the microscope will also be held. The exhibition ought to be exceedingly interesting, and we make no doubt it will be a great success.

The Development of the Tadpole.

By J. W. Gatehouse, F.I.C.

Part VII. Plates XVII. and XVIII.

THE development of brain and muscle, the organs of the will and sensation, and the moto-mechanism whereby the will places itself in relation to external objects, is the subject of the present paper.

Brain and muscle are as necessary to each other as is the boiler to the piston of the steam-engine; without fire and boiler to generate steam, the piston could not move, and without the brain or similar exciting agency muscle would remain quiescent although possessed of the inherent property of contractility. In the boiler we know that water is by heat changed into a gas occupying some two thousand times the bulk of the original liquid, and it is by the pressure thus generated that the moving mechanism is set in motion.

Where in the brain shall we find the analogue of this? Whence does the will originate? What is the nature of the force transmitted from the brain through the nerves to the muscles? We know that certain nerves are capable of being affected by definite sensations and by no others; but what causes the difference in the capabilities of various nerves appears to be totally unknown to us in the present state of our knowledge.

These psychological questions, though most interesting, cannot be answered, and even if they could be, do not fall within the scope of these papers, which treat of purely physiological conditions, and deal only with the visible changes undergone by any organ from its commencement to the period of full development. In the diagrams accompanying the former papers on this subject will be found numerous stages of the development of the brain and spinal cord, special reference being directed to Plate II., Figs. 1, 2, and 10 of Part I.; Figs. 4 and 5, Plate VII.; and Figs. 2, 3, and 4, Plate VIII., Part II.; Figs. 2 and 3, Plate XIII., Part III.; Fig. 1, Plate XX., and Fig. 1, Plate XXI., Part IV.; and Figs. 1 and 3, Plate XI., Part VI.: which taken together give

some general outline of the chief changes in form undergone by the brain from the very earliest stages.

As already mentioned in page 37, Vol. I., the first indications of brain development is seen in the formation of a canal, called the neural canal, formed by the upper end of the egg first becoming flat, then depressed, and ultimately the sides of this depression close together to produce a groove, called the medullary groove. When this medullary groove has become quite closed and thus converted into a perfect canal, the spinal cord is formed within it, first, as an aggregation of very dark nucleated cells, grouped together so as to leave a central vacant space of about the same diameter as a single cell, represented on a small scale in Plate II., Figs. 1 and 3, of Part I., N.S. These dark cells, though perfectly separate and very distinguishable from the mass of loose tissue, composed of much larger cells surrounding them, do not present any definite grouping amongst themselves, except that they may very roughly be divided into three or four layers. Individual cells, however, of the same size, form, and character occur at some distance from them towards the edge of the segmentation cavity which exists immediately below the principal mass. It is difficult from the intense blackness of these cells to distinguish their real characters, but their general appearance is that of a cell surrounded by a dense cell-wall, and containing a crowd of very black nuclei, as attempted to be delineated in Plate XVII., Fig. 1.

This hollow rod soon takes the form of an oval tube with a narrow, elongated bore, the sides of which rapidly approach each other about the middle point, but rather nearer the lower than the upper end, and thus the single tube becomes separated into two tubes—the lower one much smaller than the upper. The walls of this tube consist of elongated cells, the external ones—that is, those farthest from the centre—being much darker and far more elongated than the interior ones. Many of the dark cells are branched inwards and terminate on the exterior in small knobs, whilst the branched interior portions are connected with the lighter-coloured cells forming the inside portion of the brain. Although it was not possible to make out the connection in every case, yet in a number of instances it is certain that these two

apparently distinct sets of cells form but one series, having the shape of a flask, the neck being the darker, and the body of the flask the lighter portion.

This flask-shaped cell is contained within a delicate sac, or rather the contents of the cell appear darker than its surroundings. From the great variations in form obtained from various sections taken from animals of the same date, it becomes extremely difficult to follow the real alterations in shape which this tube undergoes for a day or two; but from a careful examination of a large number of sections of eggs taken from the 5th to the 7th of March—that is, about a week after being deposited—it appears as if the front portion of the original tube became bent at almost a right angle and formed the fore and mid brain, whilst the longer and thinner part became converted into the medulla oblongata and spinal cord.

The whole brain, together with the spinal cord, is by this time perfectly distinct and well differentiated throughout its course from the structures surrounding it, and has also undergone a great change as to the form of its individual cells. This chiefly consists in the great increase, both in number and size, of the dark portions of the flask-shaped cells before mentioned, so that, except in the thinnest sections, it is impossible to make out anything but a black mass interspersed with lighter dots. The cerebrum has, however, already commenced to become somewhat differentiated into lobes, these taking the form of slightly darker aggregations and swollen masses of cells, with lighter portions intervening. The original hollow tube has in front become completely filled up, and is only represented behind by the apparently double spinal cord, which may, however, have a double appearance only from being sections taken from a tube, and this, on a comparison of all the sections from a single specimen, is found to be actually the case, as the upper and lower sections of the cord show a single line, whilst the division between the two portions of the cord is greatest in the central section.

It will be seen from an inspection of the diagram in Fig. 2, Plate XVIII., of Part II., which gives a sketch of the animal at this period, that it has no tail, a rudiment of this organ only appearing; but in the course of three days the creature takes quite

a new form, possesses a well-developed tail, has acquired swimming powers, and with them the brain has undergone a complete change in form, the whole length from the top of the tail to the very apex of the head becoming once more divided into two parts. Meeting at the upper portion, these parts diverge most widely in the head across the line of the auditory capsules, and these once again take the form of a somewhat elongated tube compressed in the centre, shown in Fig. 4, Plate XX., Vol. I., N.S. Although there is a great diversity of form in the shape of individual cells, yet a great majority of them are still flask-shaped, but with immensely attenuated, jet-black necks, giving especially to the medulla oblongata the appearance of transverse striation, as the vast majority of the cells all lie parallel to each other across the axis of the cord.

The next noticeable alteration in form is occasioned by a transverse division across the middle line of the brain, thus distinctly making a separation between the fore and mid brain, which had only previously been marked by the general configuration. At this period also both the eye and ear sacs are partially enclosed by cells which have still the same character as those of the brain proper, but from the portion of the brain which ultimately forms the optic lobes, several sections of March 19th show a chain of oval bodies running through the general mass from the front part of the immature optic lobes to the back of the eye. The links, so to speak, of the chain are not more than one-thousandth of an inch in length and about one-half this in breadth, and probably represent an early stage in the formation of the optic nerve. The changes occurring at this time also include the formation of the ventricles by the approximation of the sides of the double brain in some places and their separation immediately below, thus forming irregular triangular spaces, the central one, however, consisting of two triangles placed base to base. These spaces or ventricles are not yet lined by any membranes, but the necks of the flask-shaped cells previously mentioned may be observed spreading out over the surface and uniting so as to form a layer which soon becomes distinctly different from the remaining portion, in forming a chain of cells arranged end to end, instead of being crowded into parallel masses. This

arrangement extends throughout the whole spinal cord, but the two portions approximate nearer and nearer as they reach the tail, till at last, merging with each other, they form one black line of cells, showing only the double nature of the cord, but not showing any actual division, as is manifestly the case in the anterior portion.

By the end of March the first distinct indications of the spinal cord, consisting of two kinds of material—white and grey—can be seen ; the mass of the cord is still intensely black, but is surrounded, especially in the neighbourhood of the medulla, by a mass of lighter cells cohering fairly well together. This adhesion to each other and distinct separation from the remaining portion of the cord was well seen in a section, mounted in rather fluid balsam. After the edge was well set the interior remained fluid, but on the gentlest pressure the external white of the cord separated from the inside darker portion, and regained its original position on relaxing the pressure. Vertical sections now show a large front lobe, not unlike a hammer-head in shape, and the under portion protruding downwards, almost as far as the mouth-cavity in the form of a large crescent, the anterior horn of which is far more curved than the posterior. For some days the only noticeable change which occurs is in the formation of a most delicate membrane which envelopes the whole structure, and evidently represents one or more of the tissues, termed the Arachnoid and Pia Mater.

On April 5th long threads of nerve substance could be seen anastomosing with each other, and evidently formed by the coalition of several cells. Some of these leave the brain proper to form the nerves. It is most difficult to identify in a section any particular nerve, but a very prominent one—I believe the pneumogastric—is very easily made out. Numbers of multipolar ganglion cells also occur about this time, but can only be seen in very thin parts owing to the exceedingly dark character of the whole. They are especially abundant or can be best seen near the hollow spaces which are developing into ventricles.

About the middle of April the whole nerve system is in a most interesting transition stage, the fore, mid, and hind brains being well formed, but not arrived at their ultimate development, and the

two structures, consisting of white and grey matter, are extremely well marked out in horizontal sections. Leaving the fibrous sheath out of the question, the external coat of the spinal cord now consists of cells separated from each other by fairly parallel lines of dark material running through the whole substance and terminating externally in small, dark knobs. In the spinal cord these form two distinct margins, together making about one-half the cord, but gradually coalescing they entirely cover the medulla. The space between is most distinct and occupied by small round nucleated cells entirely free from the dark lines mentioned above. In the tail region the cord thus appears in vertical section to be divided into three parts—the two external ones dark and the internal light.

The pineal gland can now also be well traced, and, indeed, its complete structure made out. Reserving this for another time, I will only now give an outline as to its position and parts. Situate immediately behind the lobe of the cerebellum and over the medulla oblongata it forms a distinct depression in the latter, to which, however, there is no corresponding external depression, the eye or gland filling up the space.

Bounded externally by the light ectoderm—as indeed are all other parts of the animal—and resting immediately below the dark epidermis, it forms a large and well marked microscopic object. It may be described roughly as an elongated oval sac, having a transparent, reticulated, rounded portion in front just below the skin; below this again, and also enveloping it, is a fine granular mass, which apparently corresponds to the nigrum pigmentum of the real eye, but is not nearly so dense; and below this again is a follicular mass. By this term, "follicular mass," it must not be thought that I mean this portion to have the functions of a follicle, but in its general branched character it possesses far more of the external characters of a follicle than of a retina. This mass extends downwards towards the medulla, and is extended both anteriorly and posteriorly, being in both directions connected with a nerve, the anterior portion of which is attached to the cerebellum and the posterior to the medulla, the connection with the dark external coating of this being very well marked. From a single cord it gradually spreads out, embracing a goodly

portion of the medulla—at least, one-sixth of its diameter—and reaches nearly to the spinal cord.

The changes now undergone, both in form and internal arrangement, of the two kinds of cells, ultimately known as white and grey matter, or medullated and non-medullated nerve-fibres, of which the brain and spinal cord are composed, are so many and complicated, that readers of this article would be more wearied than edified were an attempt made to chronicle them all. We will therefore merely describe some of the more salient features in this organ on three days—one April 30th, when there were no external signs of the hind limbs; another on May 11th, when the hind limbs had commenced to show, but were not fully extruded; and an intermediate one of May 4th. The cerebrum first takes a somewhat globular form, and in horizontal section is seen to consist almost entirely of dark cells, but surrounded with whiter ones. This portion of the brain, as well as the whole nerve-cord, it will be remembered, has been double for a long time; but now a cavity, lined with white cells, forms in each hemisphere, and the grey matter stretches across the centre, forming the lamina terminalis, whilst the side cavities form the lateral ventricles. The mid-brain, containing the optic lobes, is now very elongated, the lobes being well separate from each other, and consisting of two hemispherical masses of dark matter lined with lighter cells, though still of the same general character as the darker ones, and surrounded by a thick mass of most delicate fibres arranged parallel with each other, and apparently similar in structure to the optic nerve, which can be plainly seen branching out from them and proceeding to the retina. Each fibre consists of a delicate thread, which enlarges at unequal distances in its course into an oval, nucleated body. Lines of these long, nucleated fibres also extend around the base of the optic lobes, running in a general direction at right angles to the longitudinal mass.

On May 4th, horizontal sections show the fourth ventricle to perfection as a triangular cavity with the apex behind, and the front bounded by the bases of the optic lobes. Within this ventricle we find a chain of nerve-ganglia proceeding down its centre, consisting of a delicate fibrous cord with nucleated

enlargements, like that previously described as surrounding the optic lobes and forming the optic nerve. Around this cord are congregated masses of comparatively large, rounded, nucleated cells, arranged in racemose groups; and branching off from these we have a number of fibres proceeding outwards on both sides, and passing through the boundary of the medulla to other portions of the system. Ten pairs of these can be readily counted, running in somewhat irregular lines from the centre to the outside of the medulla. Each fibre is in structure a repetition of the central mass, being composed of a chain of elongated nerve-cells, surrounded by round, nucleated cells. The round cells surrounding the central chain are not all of an identical nature, as the more central ones forming a distinct racemose layer stain readily with iodine, whilst those of the branches stain better with picric acid.

Careful focussing with high powers shows me that, whereas in the posterior part of the ventricle the nerve-chain of the branches is in close proximity to the mass of rounded cells running beneath it, this is not the case with the first four front branches, which on the whole point in a forward direction, whilst the remainder point backwards. These consist of a double nerve-chain placed on a distinctly higher level than the mass of rounded cells seen at the same time. This double chain branches before it leaves the medulla, and in the case of the third from the front each portion of the chain branches, so that, instead of there being two parallel there are four diverging chains of nerve-matter.

To complete the unity of the whole and the connection between this and the rest of the brain, very small fibrils are given off from each portion of the chain, which, looping into each other, form a chain surrounding the whole, and this is extended in front to a ganglion on either side, where it is connected with other chains of nerve-matter proceeding from the exterior of the cerebrum and optic lobes. Diagrams of these observations can be seen in Figs. 4 and 5, Plate XVII.

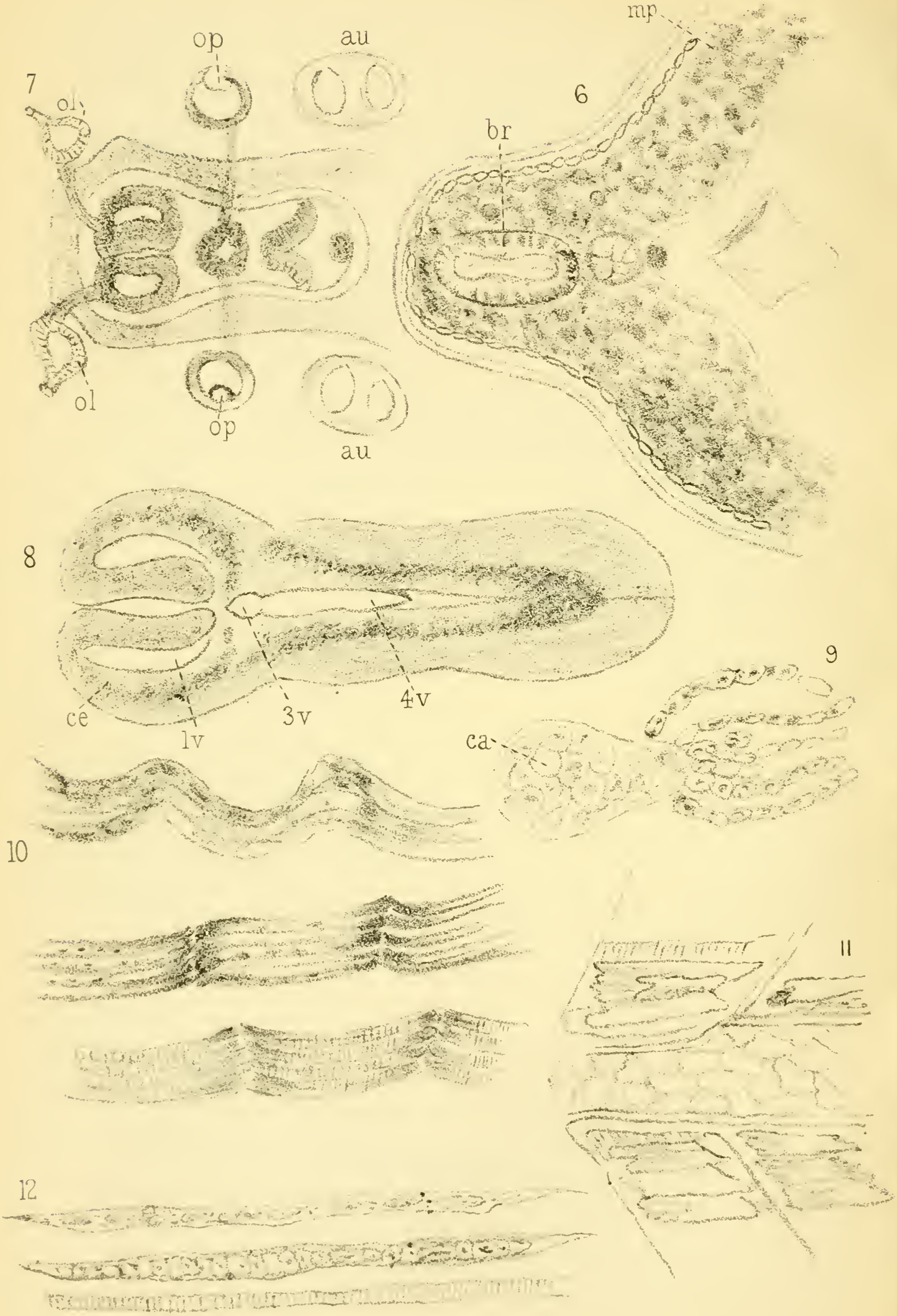
From the very earliest period the nerve-cells, hitherto described, have been associated with others, which from simple cells have ultimately developed into muscle. Some of these are seen in Fig. 1, Plate XVII. The muscular system is divided into two

distinct sets—the one voluntary, the other involuntary; the one seen in all muscles employed in the movement of the various organs of the body which are under the direction of the will; whilst the other set is to be looked for in such structures as the arteries, intestines, etc., whose muscular powers are not under the control of the will.

The voluntary muscular system has from the very first a most intimate connection with the brain, as seen in Fig. 2, Pl. XVII., where the connection between the two may be traced, the muscle-plates running down on either side of the brain in wavy lines and ultimately losing themselves in undifferentiated yelk-tissue. Before taking on this wavy character, these muscle-plates consist of rounded cells, and may be traced as a direct continuation of the mesoblast all round the egg several days before it leaves the capsule, at the sides consisting of only one layer of cells, but in the front part, where the greatest amount of development is going on, they form a layer of six or more rows. Each cell can be traced as a distinct round body, but soon arranging themselves in lines they commence to elongate much faster than the whole egg grows in the same direction, and are thus thrown into wavy lines of cells, the wavy character being first observed nearest the notochord and undifferentiated yelk.

Although I have not been able to trace the exact steps in the process, I am inclined to think that many of these cells join together to form one long cell, because in sections whose life-history is separated by only two days, one contains chains of round cells touching each other, whilst the other contains distinct waves of elongated cells, which run from the front and embrace the most important portions of the embryo. These muscular lines becoming less wavy lengthen out and envelope the whole brain and notochord at a point nearly as far as the blunt termination of the latter. Divisions between the wavy parts are seen at an early stage, but they become more pronounced and numerous till the full number have been attained, which does not take place until the creature has a strong and fully-grown tail.

It will be remembered that voluntary and involuntary muscles can be readily distinguished by the striped character of the one and the unstriped character of the other. This is, however, by no



Development of the Tadpole

means the case at first, as all muscle, even after possessing much of the character of real muscle, is unstriped. Not till quite the end of March could the division of the muscle bands of the back and tail be found to be striped, these being the first to become possessed of this character. All muscle at first is of this unstriped nature, and does not become striped till it has become capable of being used by the animal in the movement of the organs to which they are attached. A peculiarity with respect to the tail muscles is that before their degeneration they lose their striped appearance, and the parts separate from each other, looking almost like so many minute rods, which, having been at one time in a bundle, have become separated from each other and broken at their ends. The tendons whereby the muscles are attached to the bones appear in early stages to be derived from the sarcolemma, or covering, which surrounds each fibre of a muscle. This sarcolemma appears stretching from each individual muscle-fibre, and coalescing together into a point is thus inserted into the cartilage and attached to the bone.

EXPLANATION OF PLATES XVII. AND XVIII.

Figs. 1, 2, 6.—Early stages of brain and muscle.

Fig. 3.—Vertical section of brain, showing the commencement of separation into lobes.

,, 4.—Horizontal section of brain of April 30th, showing cerebrum with lateral lobes, mid-brain with optic lobes, and distribution of white and grey matter in striated lines, and medulla oblongata, etc., with commencement of ten pairs of nerves, bounded on either side by a chain of cartilage, showing commencement of vertebræ.

,, 5.—Vertical section of brain, with pineal gland.

,, 7.—Vertical section, showing olfactory and optic nerves, with position of auditory sacs.

,, 8.—Vertical section of same, showing lamina terminalis and distribution of grey and white matter, with ventricles.

,, 9.—Cartilage developing, with insertion of round cells developing into a chain of muscle.

,, 10.—Three bands of muscle fibre, in different stages.

,, 11.—Muscle of the tail desquamating and being absorbed.

,, 12.—Three muscle fibres, in different stages, showing separate nuclei arranging themselves so as to form striped muscle.

n.c., neural canal; *m.*, muscle; *m.p.*, muscle-plate; *br.*, brain; *f.b.*, fore-brain; *m.b.*, mid-brain; *no.*, notochord; *me.*, medulla oblongata; *sp.c.*, spinal cord; *m.c.*, mouth-cavity; *au.*, auditory sac; *cb.*. cerebellum; *op.l.*, optic lobes; *ol.*, olfactory lobes; *ce.*, cerebrum; *v.c.*, vertebral column; *lv.*, lateral ventricle; 3 *v.*, 3rd ventricle; 4 *v.*, 4th ventricle; *p.g.*, pineal gland; *ca.*, cartilage.

Half-an-Hour at the Microscope,

With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

Plate 19.

Lady-Bird, Mouth of.—A few words about the composition of the *mouth* in insects. It will be best said in Professor Westwood's words, as they cannot be improved upon, and they enable me to understand it as I had never done before :—

"The *Organs of the Mouth* are, notwithstanding all their variety of form, reducible to one type of structure. They consist of six principal organs, of which four are lateral and disposed in pairs ; the two others are opposed in the opposite direction, thus,

, filling up the space left by the two other pairs, above and beneath. The upper single piece is the upper lip (labrum) ; the upper lateral pair of organs are the mandibles or upper jaws ; the lower lateral pieces are the maxillæ or lower jaws ; and the under single piece is the under lip. The three lower organs are furnished with articulated appendages (palpi).

"The first principal variation in the structure of the mouth originates in the mode of action of the various organs. Thus, when the lateral pieces are short, inserted at a distance apart, and have a horizontal motion, the action is that of biting ; when, on the other hand, the lateral pieces are elongated, originating near together, and having a longitudinal motion, the action is that of sucking, the ascension of fluids in the latter case being produced by the gradual approximation of the pieces of the mouth, which thus form a syphon or haustellum" ("Modern Classification of Insects," page 8).

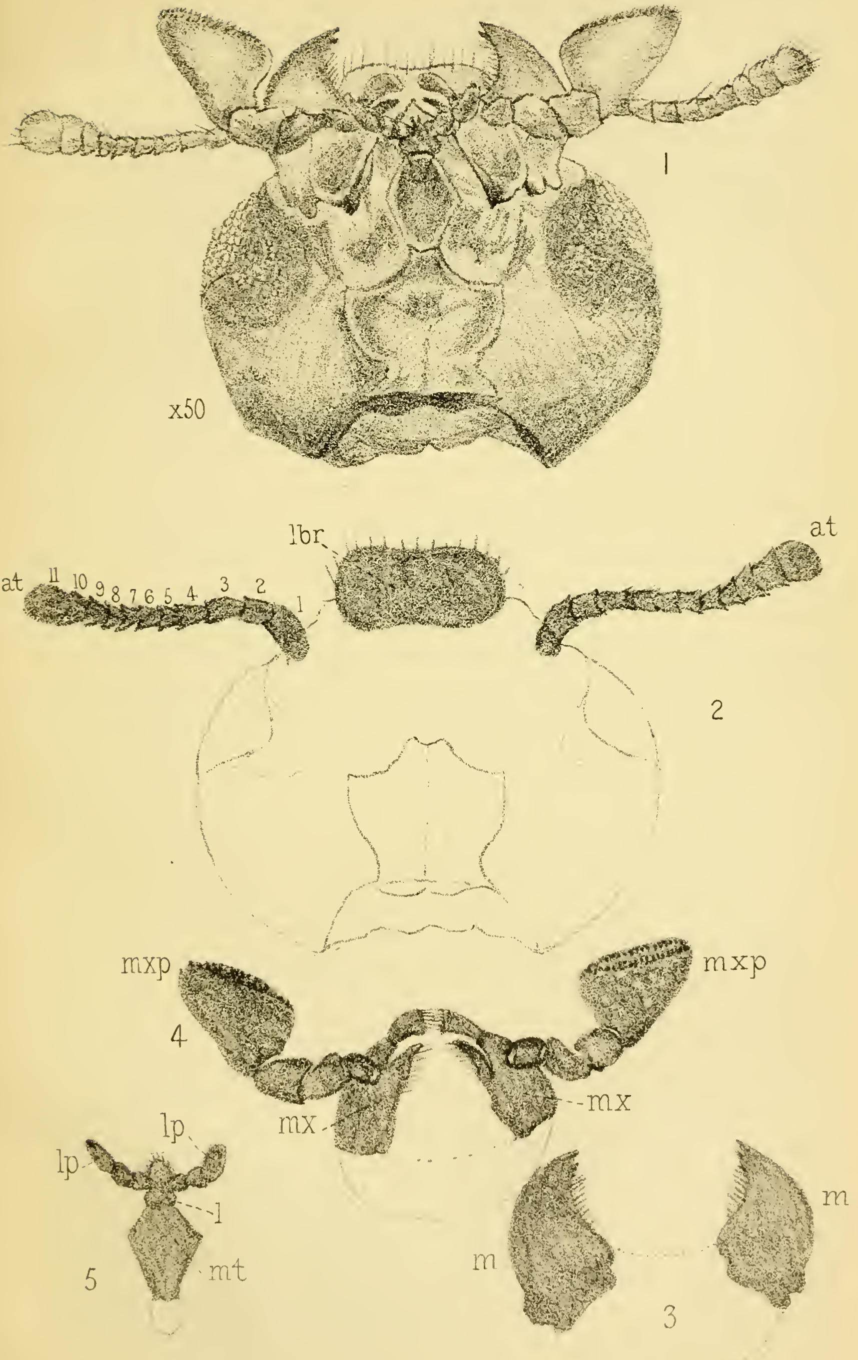
The figures will, it is hoped, serve to illustrate the above quotation. I must ask those of our members who are familiar with these subjects to bear with me in the endeavour to simplify them. All have not had equal advantages, and the special design of these remarks is to smooth over the difficulties which beset all beginners.

Master the parts of the mouth in this species, and we shall be ready to discuss forms more difficult to understand as they come under our notice.

EXPLANATION OF PLATE XIX.

Fig. 1.—Head of Changeable Lady-bird.

,, 2—5.—Parts of the mouth dissected and arranged so as to build up a model of the head.



Head of Lady-bird

Fig. 2.—*at. at.*, antennæ, consisting of 11 joints ; *lbr.*, labrum, or upper lip.

,, 3.—*m.m.*, mandibles ; the strong, prehensile outer jaws, whose special design is to seize hold and roughly bruise food. They not unfrequently, as in the present case, have a fringe of hairs along the inner margin.

,, 4.—*mx. mx.*, maxillæ, inner lesser jaws. The maxillæ, with very few exceptions, have invariably palpi attached to them, here marked *mx.p. mx.p.*, maxillary palpi. The hatchet shape of the terminal joints of the *mx.p.* is one of the generic characters of the *Coccinella.*

,, 5.—*mt.*, mentum, chin ; *l.*, labium, lower lip ; *lp.*, labial palpi. In making a model of the mouth the shaded portions only of Figs. 2—5 should be coloured.

Drawn by Mr. Tuffen West.

Selected Notes from the Society's Note-Books.

Potassic sulphate is an object which I have seldom seen except in my own collection. The chemical formula for this salt is $K_2 SO_4$, or more exactly SO_2 (KO_2). It is remarkable for crystallising in two distinct forms. One cannot fail to observe the multitudinous shapes the crystals have assumed here. F. J. ALLEN.

Sections of Stems of Plants.—It is perhaps hardly necessary to remind members of the P.M.S., that the stems of both Exogens and Endogens are made up partly of cellular tissue and partly of bundles of vessels and woody fibres, the difference between them being that in the former the fibro-vascular bundles form woody wedges arranged in concentric zones, and increasing by additions to the outside; whereas in Endogens the bundles are scattered throughout the stem, those newly formed being in the interior of the stem and curving outwards below towards the circumference, where the bundles are in consequence more crowded. Exogenous stems have a distinct pith and bark; Endogenous stems have not.

In *Euphorbia amygdaloides* the wedges of woody tissue are very small in proportion. In herbaceous Exogens, as the dahlia, it frequently happens that the exterior of the stem grows so fast that the pith-cells in the centre cannot keep pace with it; hence, an empty space is left, and we have a hollow stem, in most cases, however, solid at the nodes or points where the leaves are jointed on to it. The same thing sometimes happens in Endogens, particularly among the grasses, which have almost invariably a hollow

stem. At the nodes where the stem is solid, a transverse section displays the usual endogenous structure. The aerial root of the Screw Pine (*Pandamus*) shows a similar arrangements of parts, but the woody bundles are not so crowded towards the circumference. Sarsaparilla root, which is yielded by several species of *Smilex*, resembles in structure an exogenous stem, having a distinct pith and bark. The *Smilaceæ* have leaves with netted veins, and are a link between the Exogens and Endogens.

H. F. PARSONS.

Cuticle of Equisetum bears a striking resemblance, on a small scale, to its fossil cousin, *Sigillaria*, a resemblance, I presume, merely superficial, as the dots in pairs at regular intervals in Equisetum are stomata, which the large scars on Sigillaria can hardly be. H. F. PARSONS.

Palate of Limpet is remarkable for its great length, when unrolled being about one and a half times the entire length of the animal's body. The easiest way to extract palates of mollusca is to dissolve away the soft parts with caustic potash solution, but they do not polarise well after this treatment. H. F. PARSONS.

Palatial Tooth.—This was extracted from what is known as the Bone Bed (Lyme Regis). I find the material is quite full of very small teeth, both palatial and incisor, and of many forms. Has this particular bed been studied, and can anyone give any information as to the character of the life at the period of the deposition of this Bone Bed? J. BUTTERWORTH.

Equisetum.—The markings on the cuticle of Equisetum, alluded to by Dr. Parsons, are generally understood to be stomata. But how strange that stomata have not yet been found in the structure of its fossil representative, the *Calamite*. I have a section of fossil plant, showing stomata splendidly, but it has no Calamitian affinities. J. BUTTERWORTH.

Bone Bed, Lyme Regis.—This bed has been described by (the late) Mr. Charles Moore, of Bath, in the *Journal of the Geographical Society*, Dec., 1867, and there is to be found in his museum at Bath the finest series in the world from this particular bed. There are in this museum more than 500,000 specimens from this bed alone. A. ALLEN.

Scotch Fir.—I do not think it is generally known that the sap of the Scotch Fir contains very beautiful crystals. Now (Jan.—Feb.) is a good time for obtaining them; but I find they are very difficult to mount. Cut a slice from the underside of Fir branch. In a few days the sap will flow, and by placing a slide to the branch enough sap will be found to adhere to it. S. C. HINCKS.

Reviews.

Journal of Morphology. Edited by C. O. Whitman and E. P. Allis, jun. (London: W. P. Collins, 157 Gt. Portland St. Boston, U.S.A.: Ginn and Co.)

The third and concluding part of Vol. II. is a specially thick number, consisting of 261 pages, with many fine plates and woodcut illustrations. It contains the following papers:—Uterus and Embryo of I.—Rabbit, II.—Man, by C. S. Minot; The Anatomy and Development of the Lateral Line System in Amia Calva, by E. P. Allis, jun.; on the Organisation of the Atoms and Molecules, by Prof. A. E. Dolbear; Some New Facts about the Hirudinea, by C. O. Whitman; Segmental Sense Organs of Arthropods, by Dr. W. Patten. The new part of this high-class journal fully maintains its scientific pre-eminence. It is evident that no expense is spared on its production. The names of the scientific specialists contributing to its pages are a guarantee of the excellence of its articles. We wish it every success.

The Naturalist's Gazette. (London: W. P. Collins.)

This is a new monthly magazine, published at one penny, consisting of 8 pages foolscap folio, in a wrapper, the third page of which is devoted to exchanges, etc. It treats of a great variety of subjects in all departments of natural history, including microscopy.

Die Naturlichen Pflanzenfamilien. Edited by A. Engler and K. Prantl. (London: Williams and Norgate. Leipzig: W. Engelmann.)

Nos. 26 to 34 inclusive of this valuable botanical work are to hand. These contain descriptions of the following families:—Proteaceæ, Loranthaceæ, Araceæ, Lemnaceæ, Sparganiaceæ, Aponogetonaceæ, Triuridaceæ, Loranthaceæ, and Olacaceæ, by A. Engler; Monimiaceæ, Lauraceæ, Hernandiaceæ, Aizoaceæ (Ficoideæ, Mesembrianthemaceæ), Portulaceæ, Caryophyllaceæ, by F. Pax; Papaveraceæ, by K. Prantl and J. Kundig; Hydrocharitaceæ, by P. Ascherson and M. Gürcke; Orchidaceæ, by E. Pfitzer; Potamogetonaceæ, by P. Ancherson; Juncaginaceæ, by Fr. Buchenau and G. Hieronymus; Alismaceæ and Butomaceæ, by Fr. Buchenau; Phytolaccaceæ, by A. Heimerl; Myzodendraceæ, Santalaceæ, and Grubbiaceæ, by G. Hieronymus; Cucurbitaceæ, by G. O. Müller and F. Pax; Campanulaceæ, by S. Schönland. These numbers contain 232 illustrations, composed of 1272 figures. Vols. II. and III. of this fine work are now completed.

Shall we Teach Geology? A Discussion of the Proper Place of Geology in Modern Education. By Alexander Winchell, A.M., LL.D., F.G.S.A., etc. Cr. 8vo, pp. x.—217. (Chicago, U.S.A.: S. C. Griggs and Co. 1889.)

Dr. Winchell thinks that the proper position of Geology is very much under-estimated in the Schools of the United States. The same may, we fear, be said of it here. He therefore seeks, in the book before us, to set forth the value of geologic study as he estimates it, as he feels it, and as he has learned it by much practice in the teaching of a wide range of subjects.

The Psychic Life of Micro-Organisms: A Study in Experimental Psychology. By Alfred Binet; translated from the French by Thos.

McCormack. Cr. 8vo, pp. xii.—120. (Chicago, U.S.A.: The Open Court Publishing Co. 1889.)

The author attempts to show "that psychological phenomena begin among the very lowest classes of beings. They are met with in every form of life, from the simplest cell to the most complicated organism."

YEAR-BOOK of the Scientific and Learned Societies of Great Britain and Ireland. Sixth annual issue. 8vo, pp. v.—234. (London: Charles Griffin and Co. 1889.) Price 7s. 6d.

This work contains lists of the papers read during the year 1888 before Societies engaged in fourteen departments of research, with the names of their authors. It gives, also, the names of President, Secretary, Treasurer, etc., of the different Societies, the address of the Secretary, with the place and date of the various Meetings, and is, in fact, an invaluable scientific directory.

THE NATIVE RACES OF THE PACIFIC STATES OF NORTH AMERICA. By Hubert Howe Bancroft. Vol. V., Primitive History. 8vo, pp. xii.—796. (London: Trubner and Co. San Francisco: The History Publishing Co.)

This volume concludes the "History of the Native Races," former volumes of the series treated of the Wild Tribes, Civilized Nations, Myths and Languages, and Antiquities. The volume before us tells us that the civilized nations of Mexico and Central America had their sacred books and recorded history, carrying their annals back a thousand years; and that besides the hieroglyphics used in recording their annals they knew astronomy and had a calendar by which they marked the time. There are two maps and a thoroughly exhaustive index to the five volumes, occupying no fewer than 150 double-column pages.

THE PUPIL'S CONCISE FRENCH GRAMMAR and Useful Reader. Arranged by S. Croft. 8vo, pp. 48. (London: Relfe Bros.) Price 1s. 4d.

This grammar has been compiled for a Pupil's Home-Lesson Book, and presupposes a teacher who, with fuller works at command, will enlarge on each lesson.

NATURAL SCIENCE Examination Papers. Compiled by R. Elliot Steel, M.A., F.C.S. Part I., Inorganic Chemistry. Crown 8vo, pp. 166. (London: George Bell and Sons. 1889.)

Will be found very convenient for teachers who desire to have ready in their hands the means of testing their pupils' knowledge and progress. It is divided into two parts:—Part I., THEORETICAL, in which 892 questions are proposed. These are followed by a number of general questions. Part II. treats of PRACTICAL Inorganic Chemistry, and consists of about 130 questions.

UNIVERSITY OF LONDON QUESTIONS. By C. J. Woodward, B.Sc. Crown 8vo, pp. viii.—176. (London: Simpkin, Marshall, and Co. Birmingham: Cornish Bros. 1889.) Price 3s. 6d.

Contains Questions on Natural Philosophy and Chemistry given in the Matriculation Examination of the University of London from 1864 to 1880 inclusive, followed by Questions in Mechanics and Experimental Science from the years 1881 to 1888 inclusive. To these are added, at the end of each section, Answers and Hints on Working the Questions. We notice that throughout the book the questions are printed on *white* paper and the answers and hints on *toned* paper.

English History Notes, 1689—1727, specially prepared for the use of Army Candidates, with Test Questions. By F. Freeth, M.A. Post 8vo, pp. 120. (London: Relfe Bros.) Price 2s. 6d.

These Notes will prove of great assistance to the student of English History. The Notes are very concisely printed on the right-hand page, whilst on the left, immediately opposite, are the titles of the subjects in bold, black type.

First Lessons in Wood-Working. By Alfred G. Compton. Crown 8vo, pp. x.—188. (New York and Chicago: Ivison, Blakeman, & Co.)

This useful little book is intended principally for the use of schools in which hand-work is pursued as a part of general training. The order of sequence is designed to lead the pupil from one tool to another of larger capabilities, and from one operation to another requiring a higher degree of skill. It is chiefly intended for boys between the ages of 11 and 14. It is well illustrated, and the instructions are given in language which cannot fail to be understood. We strongly recommend it to all ingenious boys.

A Study of Man and the Way to Health. By J. D. Buck, M.D. 8vo, half russia, pp. xxii.—302. (Cincinnati, U.S.A.: Robert Clarke and Co. 1889.) Price $2.50.

The author of this work recognises the study of man as the most important in which the human mind can engage, and in the preface we have an epitome of the thesis which is elaborated in the body of the work. This opens with a chapter on the nature of evidence, and aims to discover the criterion of truth. Then follows a brief outline of the principles of biology, an important chapter being devoted to an outline of the structure and functions of the human body; followed by chapters on psychic phenomena in general, health and disease, sanity and insanity, etc.

The reader—whether medical student, physician, or layman—will find much to interest him in this book.

Man and his Maladies; or, The Way to Health, a Popular Handbook of Physiology and Domestic Medicine, in accord with the Advance in Medical Science. By A. E. Bridger, B.A., M.D., B.Sc., F.R.C.P.E., etc. Crown 8vo, pp. xxiii.—472. (London: John Hogg. 1889.)

In noticing this book, perhaps we cannot do better than quote from the preface, in which the author says:—"I have . . . . ventured to confer on man the leading *rôle*, have made him tell the story of his birth and growth, and explain the functions of, and the source of power in, that wonderful piece of mechanism, his body; to prove that he is not, as is calumniously asserted of him, the sport of malignant spirits in the guise of diseases; but the well-cared-for child of Old Dame Nature, who leads him by what are called functional disorders, as tenderly and directly as is possible, back to the paths of health when he has strayed therefrom; and purifies, by organic disease, his race of those least worthy of it or least fitted to enjoy it."

The Futility of Experiments with Drugs on Animals. By Edward Berdoe. (London: Victoria Street and International Society for the Protection of Animals from Vivisection, 20 Victoria Street, S.W. 1889.)

A little 8vo work of 46 pages; its scope is well described by the title. In respect to many of the drugs, we find opposing opinions given in parallel columns. Turning to Prussic Acid, for instance, we read, "Rossbach and others found that it lowered the frequency of the pulse." "Wahl found that it increased it."

The Essentials of Physical Diagnosis of the Chest and Abdomen. By J. Wallace Anderson, M.D. 12mo, pp. viii.—156. (Glasgow: James Maclehose and Sons. 1889.)

The author was induced to write this book in consequence of having a difficulty of referring a class of junior students to a simple, concise work on the subject, and in the hope that those beginning the study of medicine might find it of service. It is very clearly written, and will doubtless prove of much assistance to the student.

Physiological Diagrams for Use of Schools. (Edinburgh: W. and A. K. Johnston. 1889.) Price 6s. per set, or mounted on cloth 14s. per set, with key.

These diagrams are comprised in nine sheets, the size of each being 23 by 30 inches. Sheet I. shows the Entire Skeleton, in which all the bones are numbered or referred to by letter; II., The Arm: Muscles and Bones; III., The Leg: Muscles and Bones; IV., Vertical Section of a Hinge Joint (the Elbow Joint) and of a Ball and Socket Joint (the Hip Joint); V., Bones of the Head; VI., Front View of the Organs of the Trunk; VII., Posterior Surface of the Trachea and Lungs, Sectional View of the Heart; VIII., The Eye; IX., The Ear.

The key to the above, containing the same drawings, reduced to 7 in. by 10 in., is sold at 6d.

Atlas of the Anatomy of Labour. Exhibited in Frozen Sections. By A H. F. Barbour, M.D. (Edinburgh & London: W. and A. K. Johnston. 1889.)

This fine work, size of pages 16 by 23 inches, contains 12 plates. The illustrations are life-size, and coloured from frozen sections. It is called the Student's edition. Each plate is fully described. We consider it a splendid work.

The Illustrated Medical News. Nos. 26—38. (London: The Illustrated Medical News Publishing Co., Limited.) Price 6d. each part.

We have much pleasure in directing the attention of our Medical readers to this fine Journal. Each part contains a full-size coloured plate, and a large number of smaller illustrations in the text. Its table of contents embraces Original Articles; Leading Articles; Reports on the Progress of Medicine and Surgery; Lectures, among which we notice the following subjects:—Evolution in Pathology, by J. Bland Sutton, The Pathology of Glaucoma, by Erasmus Wilson, The Mechanism of the Heart, The Physiology of the Vascular System, The Gulstonian Lectures on Secondary Degenerations of the Spinal Cord, etc. etc. The very excellent character of this work is fully maintained.

Our Children: How to keep them well, and treat them when they are ill; A Guide to Mothers. By Robert Bell, M.D. Crown 8vo, pp. viii.—232. (Glasgow: David Bryce and Son. 1889.) Price 2s. 6d.

The information conveyed in this little book is as free from technicalities as it is possible to be; it is given in very concise language, and treats of all the common diseases to which infants and young people are subject. The author states in the preface that it must be borne in mind that it is always desirable to call in the family medical attendant at the earliest opportunity when disease exists, and only in his unavoidable absence, or until he arrives, should one trust to the guidance afforded by any book.

Woman in Health and Sickness; or, What she Ought to Know for the Exigencies of Daily Life. By Robert Bell, M.D. Crown 8vo, pp. viii.—200. (Glasgow: David Bryce and Son. 1889.) Price 2s. 6d.

Another useful book by the same author, it contains a large amount of information, written in language which will be readily understood.

Spacial and Atomic Energy, Part I. By Frederick Major. Crown 8vo, pp. 62. (London : Eyre and Spottiswoode. 1889.) Price 1s. 6d.

This little book forms the introductory part of a work that, although partly completed, may require many years of labour yet to be devoted to it. It is divided into two chapters—Great Causes (Solar Heat and Cause of Gravitation) and Inductive Effects (Electricity, Magnetism, Heat, Light, the Electric Current). It is proposed to publish succeeding parts as soon as ready.

The Radical Cure of Hernia. By Henry O. Marcy, A.M., M.D., LL.D. pp. vii.—251.

The Etiology, Diagnosis, and Therapy of Tuberculosis. By Prof. Dr. H. von Zeimssen ; translated by David J. Doherty, A.M., M.D. pp. 119. (Detroit, Mich. : George S. Davis. 1889.)

Two of the valuable series of works which are published monthly under the title of The Physician's Leisure Hour Library ; the price of each part being, in paper covers 25c., in cloth 50c.

Lectures on Massage and Electricity in the Treatment of Disease. By Thomas Stretch Dowse, M.D. 8vo, pp. xix.—379. (Bristol : J. Wright and Co. London : Hamilton, Adams, and Co.)

These lectures treat of Massage and the methods of applying Massage ; Electro-Physics and Electro-Therapeutics. The author tells us that he has endeavoured to deal with the problems involved in a spirit of scientific enquiry and research, and lays no claim to any special merit or originality. He brings forward no *wonderful* cases that he has cured, his chief aim being to set forth the results of his experience and labours in a plain statement of facts. The book is well illustrated.

Arminius Vambery : His Life and Adventures, written by himself. With an introductory chapter, dedicated to the Boys of England. Square imp. 16mo, pp. xix.—350. (London : T. Fisher Unwin. 1889.) Price 6s.

In a most attractive style the author gives a narrative of his Travels and Adventures in Asia and Europe. He tells us that they make no pretence to be a geographical and ethnological description of the actual Central Asia. The work is now in its fifth edition, and is partly an autobiographic sketch of the author, and in a greater measure an account of a courageous and very successful attempt to explore a country at that time almost unknown. The work cannot fail to delight the boys of England. It contains a portrait of the author and 17 full-page plates.

Holland. By James E. Thorold Rogers. Crown 8vo, pp. xxiii.—388. (London : T. Fisher Unwin. 1888.) Price 5s.

This work is one of the "Story of the Nations" series, and will be found to be of deep interest. It recounts some of the principal facts in perhaps the greatest and most important of European wars : that in which the seven provinces of Holland secured their independence against the monarch who was supposed to possess the mightiest powers of the age. It contains nearly 60 full-page and other engravings.

Assyria, from the Rise of the Empire to the Fall of Nineveh. By Zénaïde A. Ragozin. Second edition. Crown 8vo, pp. xix.—450. (London : T. Fisher Unwin. 1888.) Price 5s.

Another of the "Story of the Nations." This book is a continuation of "Chaldea," recently published by the same author, and will be found to be deeply interesting. It is illustrated with 80 maps, plates, and other engravings.

THE MIDDLE LIAS OF NORTHAMPTONSHIRE. By Beeby Thompson, F.G.S., F.C.S. 8vo, pp. 149. (London: Simpkin, Marshall, and Co. Birmingham: *Herald Press.*)

In this work the author treats of the Middle Lias Stratigraphically, Palæontologically, Economically, as a Source of Water Supply, and as a Mitigator of Floods. These papers first appeared in the *Midland Naturalist.* They contain a full account of the Middle Lias, the depths of the various beds, with the names of the fossils found in them. The question of water supply is carefully considered, and two plates are given, one being a section across the Nene Valley between Northampton and Hardingstone; the other, a section of a proposed well, reaching from the surface to the Lower Lias.

BATH, Old and New: A Handy Guide and a History, with maps and illustrations. By R. E. M. Peach. Crown 8vo, pp. xvi.—294. (London: Simpkin, Marshall, and Co. 1888.)

This interesting work opens with an account of Ancient Bath, in which the story of Prince Bladud and the pigs is pleasantly narrated, the occupation of the Romans, and other events up to recent times. The history of Modern Bath comprises, of course, the greater portion of the book, and very fully describes the Ancient Roman and the various modern baths and the waters, the public buildings, places of worship, etc. In an appendix an account is given of the antiquities of the surrounding district. It is illustrated with Woodburytype and other illustrations, and a large folding map of the city.

BOURNEMOUTH as a Health Resort. By A. Kinsey-Morgan, M.R.C.S.Eng. 8vo, pp. 98. (London: Simpkin, Marshall, and Co. Bournemouth: E. J. Bright and Son. 1889.)

This interesting book, written by the Medical Officer of Health, describes the Geological Aspect of Bournemouth, Domestic Water Supply, Sanitary and Insanitary Houses, etc., the Climate of Bournemouth, Balneology (which we find means Hydrology) in relation to Bournemouth, Sea-Bathing, etc. The book is nicely illustrated.

BRIGHT'S ILLUSTRATED GUIDE TO BOURNEMOUTH. Compiled and edited by C. H. Octavius Curtis, F.S.A. Crown 8vo, pp. 196. (London: Mason and Payne. Bournemouth: F. J. Bright and Son. 1888.)

In addition to a pleasing description of Bournemouth; Christchurch, New Forest, Parkstone, Poole, etc. etc., are also shortly described; to which are added papers on the Climate, Geology, Flora, and Fauna of the neighbourhood. It contains also a map and ten illustrations.

EVERYDAY HEROES: Stories of Bravery during the Queen's Reign, 1837—1888. Crown 8vo, pp. 222. (London: Society for Promoting Christian Knowledge.) Price 2s. 6d.

These stories, which are compiled from public and private sources, give the accounts of such noble deeds as those of Grace Darling, Braidwood the Fireman, and many others.

A NATURALIST'S VOYAGE ROUND THE WORLD. By Charles Darwin, M.A., F.R.S., etc. Post 8vo, pp. x.—519. (London: John Murray. 1889.) Price 3s. 6d.

This is the Journal of Researches into the Natural History and Geology of

the Countries visited during the voyage of H.M.S. "Beagle" round the world under the command of Capt. Fitzroy, R.N. It is a work which should find a place in every library. A fine-engraved portrait of Charles Darwin forms a frontispiece to the volume.

DARWIN'S JOURNAL during the Voyage of H.M.S. "Beagle" Round the World. Edited by G. T. Bettany, M.A. 12mo, pp. xx.—381. (London: Ward and Lock. 1889.) Price 2s.

A still cheaper edition of the work just noticed. We trust few libraries will be without a copy. This also has a portrait of Charles Darwin as frontispiece.

LIFE. By Count Lyof N. Tolstoi. Authorised translation by Isabel F. Hapgood. Crown 8vo, pp. 295.

CHILDHOOD, BOYHOOD, AND YOUTH. By Count Lyof N. Tolstoi; translated from the Russian by Isabel F. Hapgood. Crown 8vo, pp. ix.—388. (London: Walter Scott. 1889.)

The above are translations of two works by this celebrated Russian author. The first treats of Life from various aspects, and is divided into 34 chapters; the second, although described as novels, is said to contain many points which may be recognised as having been true of himself at the ages therein dealt with.

LIFE OF FREDERICK MARRYAT. By David Hannay. 12mo, pp. 163. Bibliography, viii. (London: Walter Scott. 1889.) Price 1s.

We are all well acquainted with the writings of Captain Marryat. The little book before us offers a good opportunity to his many readers to become acquainted with some of the more important events of his life. The bibliography is supplied by Mr. John P. Anderson, of the British Museum.

THE PLAYTIME NATURALIST. By Dr. J. E. Taylor, F.L.S. Crown 8vo, pp. xvi.—287. (London: Chatto and Windus. 1889.)

This is thoroughly a book of the right sort; we know of none better to put into the hands of a schoolboy. It is written in an easy, free, conversational style, and cannot fail to be appreciated by our young friends. It tells how a Natural History Society was formed by the boys of Mugby School, and what they discovered and learnt about fishes and the diversified shapes of their scales, butterflies with their eggs and caterpillars, land-shells, etc. etc. It contains 366 illustrations.

BY LEAFY WAYS: Brief Studies from the Book of Nature. By Francis A. Knight. Illustrated by E. T. Compton. Crown 8vo, pp. viii.—197. (London: Elliot Stock. 1889.)

The delightful series of papers composing this volume were originally published in the *Daily News*. We are exceedingly glad to find that they now appear in a more permanent form. They will be read with much pleasure by every lover of nature. The illustrations are good, several being photogravure prints.

HAUNTS OF NATURE. By H. W. S. Worsley-Benison, F.L.S., etc., Author of "Nature's Fairy Land." Crown 8vo, pp. 225. (London: Elliot Stock. 1889.) Price 5s.

With much pleasure we hail another volume from the pen of this exceedingly pleasant writer. Mr. Worsley-Benison is an enthusiast in all departments of Natural History. We no sooner take up his book than we feel possessed with some of his enthusiasm, and forget all except the book we are reading. To say that we have read the volume with delight is but a poor expression of our feelings. We cordially recommend it to our readers.

NATURE'S FAIRY LAND. By H. W. S. Worsley-Benison. (London : Elliot Stock.)

It is gratifying to learn that this most interesting little book is now in its *third* edition.

SYLVAN FOLKS : Sketches of Bird and Animal Life in Britain. By John Watson. Crown 8vo, pp. 286. (London : T. Fisher Unwin. 1889.)

A series of 16 most interesting chapters, of which all the facts are taken first hand from Nature, and, says the author, "My harvest has been gleaned in the open in all weathers, and through every hour of the day and night." Here we have living birds and animals presented to us in their wild haunts.

WINSCOMBE SKETCHES of Rural Life and Scenery among the Mendip Hills, including the Ornithology and other Natural History of the District. By Theodore Compton. Crown 8vo, pp. 207. (London : Elliot Stock. 1888.)

This little book will prove interesting to readers generally, but to readers residing in the West of England it will prove particularly so. That the writer is thoroughly a naturalist may be gathered from the fact of more than half the chapters bearing such titles as the Wild Beasts ; the Birds, Reptiles, and Fishes ; Butterflies and Flowers, etc. etc.

THE CHESS CONGRESS of 1862. Edited by J. Löwenthal ; to which is prefixed an account of the Proceedings and a Memoir of the British Chess Association by G. W. Medley. Crown 8vo, pp. xcvi.—536. (London : George Bell and Sons. 1889.)

This work will prove of great interest to chess-players, the original edition having been for a long time out of print. It contains 200 fully-played Chess Games, many being illustrated with diagrams, and 296 Prize and other Problems. This collection of Problems embraces all those which gained prizes in the tourney under the heads of "Ordinary Problems," "Suicidal Problems," and "End Games," together with a selection from the finest of the unsuccessful ones, and includes the Prize Problems of the Bristol Meeting of 1861.

THE NINE FAMOUS CRUSADES of the Middle Ages. By Annie E. Keeling. Crown 8vo, pp. 268. (London : T. Woolmer. 1889.) Price 2s. 6d.

The twelve chapters into which this book is divided carry the reader through the eventful history of Peter the Hermit and Pope Urban to that of Saint Louis and the last Crusades. The narratives are told in an interesting manner. The book is neatly bound and nicely illustrated.

THE AUTOBIOGRAPHY OF AN ACORN, and other Stories. By James Crowther. Post 8vo, pp. 278. (London : Sunday School Union.) Price 3s. 6d.

A series of short and interesting stories, eminently adapted to arrest the attention of those for whom they were written. To the Autobiography of an Acorn is added the stories of a Pearl, a Pebble, Gold and Silver, a Honey-Bee, an Ichneumon, a Leaf, a Wheat-Grain, a Feather, a Stomach, a Sunbeam, a Journey. There are some 50 or more good illustrations.

THE PANSY, and How to Grow and Show it. By James Simkins. Crown 8vo, pp. 112. (Birmingham : Cornish Bros. London : Simpkins, Marshall, and Co. 1889.)

Treats of the History of the Pansy, Position and Situation most suitable for its Growth, Culture in Beds and Frames, Properties of Show and Fancy Pansies, and How to show them, etc. It is illustrated with coloured plates and a number of engravings.

SIR JOHN FRANKLIN: The True Secret of the Discovery of his Fate: A Revelation. By Rev. J. Henry Skewes. Crown 8vo, pp. xvi.—243. (London: Bemrose and Sons. 1889.) Price 5s.

A most remarkable book, in which we are told that, at the time of the *first* expedition sent out in search of Sir John Franklin, the little daughter of Captain Coppin, a ship-builder, of Londonderry, received a Revelation explaining exactly where he would be found, and although this Revelation was not acted on till some years afterwards, it was at the exact spot mentioned by the child that relics of Sir John Franklin were found. The author is willing to offer information of a most satisfactory nature to anyone who may seriously question the *bona-fides* of Captain Coppin or any of his children, who are all still alive. It is to be regretted that the forty years' silence has been so rigidly kept.

PSYCHOLOGY AS A NATURAL SCIENCE applied to the Solution of Occult Psychic Phenomena. By C. G. Raue, M.D. 8vo, pp. 541. (Philadelphia, U.S.A.: Porter and Coates. 1889.) Price $3.50.

The author has endeavoured to solve, on the basis of the New Psychology, the occult psychic phenomena claiming so much attention at the present day. Dr. Raue proves that materialism is incompetent to explain these manifestations, and endeavours to give a rational psychological explanation of the same. He displays rare logical powers.

BURTON'S MODERN PHOTOGRAPHY. By W. K. Burton, C.E. Crown 8vo, pp. iv.—177. (London: Piper and Carter. 1889.) Price 1s.

The eighth edition of this well-known and valuable work is before us. It treats of the whole Art of Photography, including practical instructions in working Gelatine Dry Plates, Printing, etc., and in the Appendix are given hints on Orthochromatic or Isochromatic Plates, Stripping Films, Gelatino-Citro-Chloride Paper for printing-out. There are several illustrations and a good index.

THE AMATEUR PHOTOGRAPHER'S FIRST HANDBOOK. By J. H. T. Ellerbeck. Post 8vo, pp. 82. (Bradford: Percy Lund and Co. London: Trubner and Co. 1889.) Price 6d.

A capital handbook for the amateur, in which the instructions are very plainly given. A good sixpennyworth.

A B C DE LA PHOTOGRAPHIE MODERNE. Par W. K. Burton, C.E. Traduit de l'Anglais sur la 6e edition, 1886, par G. Huberson. Troisieme edition. (Paris: Gauthier-Villars et Fils. 1889.)

A capital translation into the French of W. K. Burton's A B C of Photography.

TRAIT PRATIQUE DE PLATINOTYPIE sur Esmail, sur Porcelaine, et sur Verre. Par Geymet. (Paris: Gauthier-Villars et Fils. 1889.)

In this method of decorating enamels, porcelain, and glass, a positive silver print on a collodion film is placed in a bath of a salt of platinum until the silver is displaced by the platinum. The film is then affixed to the article to be decorated, and permanently fixed by a heat sufficient to vitrify the surface.

Nouveau Guide Pratique du Photographe Amateur. Par G. Vieuille. (Paris : Gauthier-Villars et Fils. 1889.)

This is a plain and concise guide for the beginner in photography. The author speaks highly of hydroquinon as a developer. It does not stain the film, there is an absence of fog, and the same bath may be used for several plates.

La Photogravure Facile et a Bon Marché. Par l'Abbe J. Ferret. (Paris : Gauthier-Villars et Fils. 1889.)

The mode of producing the plates for this cheap and effective method of illustrating journals is here described.

Heliographie Vitrifiable Temperatures, Supports Perfectionnes, Feux de Coloris. Par Geymet. (Paris : Gauthier-Villars et Fils. 1889.)

A treatise on the decoration of enamelled plaques and porcelain by means of photographic films, which are painted with colours that become incorporated with the glazing, when exposed to a proper heat in the furnace.

Les Portraits au Crayon au Fusain, et au Pastel obtenus au Moyen des Agrandissements Photographiques. Par C. Klary. (Paris : Gauthier-Villars et Fils. 1889.)

Those who are not satisfied with the merely mechanical methods of photography will here find full details for forming truly artistic pictures in pencil, charcoal, or crayon on photographic enlargements.

Matriculation Directory, Jan., 1889. With Solutions to the Papers (*Univ. Corr. Coll. Tutorial Series*). (London : W. B. Clive and Co., Booksellers' Row.) Price 1s.

Intermediate Arts Guide, July, 1888. With Solutions. Price 2s. 6d.

London B.A. Guide, October, 1888. Price 1s.

B.A. Model Solutions, 1888. Price 5s.

B.A. Mathematics (Questions and Solutions), 1881 to 1888. Price 3s.

B.A. Mixed Mathematics Examination Papers, 1874 to 1888, with Model Solutions for 1888, and 200 Miscellaneous Questions in Dynamics and Astronomy. Price 2s.

Homer's Iliad, VI. Text, with Translation and Vocabularies. By B. J. Hayes, B.A. Price 2s. 6d.

The "Tutorial Series," which includes the above volumes, is published in connection with the University Correspondence College, an institution which has greatly assisted in the spread of university education by its courses of practical instruction and preparation for London degrees, of which hundreds of students, scattered in all quarters, are now availing themselves. Amongst the books now before us, the "Matriculation Directory" and the "Guides" are entitled to special notice as being indispensable to all candidates for the respective examinations. They are issued immediately after the examinations, and contain all the papers that have been set, together with model solutions, lists of subjects, and copious reviews of the suitable text-books in each subject ; in short, that information which is most needed by students who rely chiefly upon self-preparation. Copies *without* the solutions are, we notice, supplied gratui-

tously to *bona-fide* students. The collections of papers in Pure and Mixed Mathematics should prove invaluable, not only to those preparing for the London B.A. degree, but also to all teachers and students requiring easy questions on Algebra, Trigonometry, Conics, Mechanics, and Astronomy; while the student armed with the "Tutorial" editions of the classics as represented by Mr. Hayes' "Iliad" will find it difficult to get into error, when historical summary, text and notes, glossary, translation, sketch of dialectic peculiarities, and test papers for examination, are all included in one volume.

A Treatise of Human Nature. By David Hume. Reprinted from the original edition in three volumes, and edited, with an analytical index, by L. A. Selby-Bigge, M.A. Crown 8vo, pp. xxiii.—709. (Oxford: Clarendon Press. 1888.)

This is a reprint of Hume's famous treatise on Human Nature, published in three volumes in 1739 and 1740. Book I. treats of the Understanding, Book II. of the Passions, and Book III. of Morals, with an Appendix, "wherein some passages of the foregoing volumes are illustrated and explain'd."

W. and A. K. Johnston's Modern Map of England and Wales. (Edinburgh and London: W. and A. K. Johnston.)

This very useful map is divided into four sheets, and may be had folded in a cloth case for 2s. each section, or mounted on cloth for 3s. 6d. As folded in case, the size 4 in. by 9 in. is very convenient for the pocket, and when opened each section is 24 in. by 30 in. The tourist will find it a very handy travelling companion.

Botany Notes for Students of Medicine and Science. By Alexander Johnstone, F.G.S. Fourth Edition. Part I., Histology and Physiology. Part II., Systematic Morphology. (Edinburgh: E. and S. Livingstone. 1888.) Price 2s. each.

Students preparing for examinations in Medicine and Science will find these notes of immense value. It is of course not to be understood that these little books of themselves will be sufficient to carry the student through the course of examinations; but those who have studied the Science from the larger manuals, will find here sufficient, in a condensed form, to refresh their memory preparatory to the exams.

Zoology Notes for Students of Medicine and Science. By Alexander Johnstone, F.G.S. Part I., Morphology, Histology, Physiology, and Protozoa to Vermes. Part II., Vermes to Arthropoda. (Edinburgh: E. and S. Livingstone.) Price 2s. each part.

These, like the Botany Notes, are intended as a help to Students who are preparing for Professional, Certificate, and Degree Examinations; they will doubtless also prove useful to those Students who are working for the Biology Exams. of the South Kensington Science and Art Department.

Anatomy. Part I., The Upper Extremity; Part II., The Lower Extremity. Crown 8vo, pp. 64 each part. (Edinburgh: E. and L. Livingstone. 1889.)

This work is also intended for Students preparing for Examinations. The information is conveyed in the form of Questions and Answers. The Answers are very concisely given, and a very large amount of information is conveyed in a small space.

Budget and Time Table of the Caledonian Railway, and the Lines with which it runs in connection. Described by Thomas Mason. Illustrated by 50 Pictures drawn by David Small.

Royal Route to the Highlands. By David Macbrayney Steamers, with 35 illustrations, by David Small. (Glasgow: David Bryce and Son.)

Two wonderful pennyworths, affording a large amount of information in small compass.

Conquests of the Cross. Part I. (Cassell and Co.)

This is another new periodical published by this very enterprising firm. The size is royal 8vo, and the numerous illustrations are good. With this part is given a large coloured plate, representing the meeting of Livingstone and Stanley in Central Africa.

Some Rules of Latin Syntax. (London: Relfe Bros.)

These are printed on a card forming 4 pages of crown 4to, and give valuable helps to the student of Latin. The rules are very concise.

Leicestershire and Rutland Notes and Queries, and Antiquarian Gleaner. A Quarterly Journal, edited by John and Thomas Spencer. Vol. I., No. 1. April, 1889. (Leicester: John and Thomas Spencer. London: E. Stock.) Price, 1s. 6d, or 4s. 6d. per annum.

Contains a large amount of information, with several good plates, very interesting to persons residing in the locality, and to Antiquarians generally.

White's Industrial Drawing Revised. (New York: Ivison, Blakeman, and Co.)

This capital work is complete in 18 books. Nos. 1 to 8, size 6 by 9 inches. Nos. 9 to 18, size 8 by 11 inches. The system provides one book for each half school year. There are no manuals required, each book being complete in itself. They contain only such work as is directly educational in its character, and which leads without waste of time to such a knowledge of the subject as is essential to every artisan or person employing such. They teach the pupils: I.—To make working drawings to scale of any ordinary object, whether requiring one or more views. II.—To draw accurately, in freehand perspective, any elementary object or group of objects, giving clear ideas of their proportions and positions, and indicating light and shade. III.—To refer to its proper school or period any ordinary type of Historic Ornament. IV.—To compose original decorative designs possessing strength, beauty, and character, and in harmony with the purpose for which they are intended.

Life Lore: A Monthly Magazine of Natural History. (London: W. Mawer, Essex Street, Strand.)

The first volume of this magazine, so full of interest to the naturalist, is completed with the June part. We understand that the July, and all other succeeding numbers will be published at *Fourpence*, and that no change of any kind will be made in its appearance.

What shall we have for Breakfast? or, Everybody's Breakfast Book. By Agnes C. Maitland. 16mo, pp. 120. (London: John Hogg. 1889.)

In this little book, 181 different dishes are suggested for breakfast, with recipes for preparing them.

Some Incidents in the Life of a Fox-hound: an Autobiography. By Raleywood Cleveland, edited by L. F. M. S. Crown 8vo, pp. 188. (York: Sampson Bros. 1889.)

The Autobiography, although dated in the preface 189—, should certainly have been dated a hundred years later. It is very amusing, and will doubtless be acceptable reading to many readers, especially to those in the neighbourhood of Cleveland.

SONGS OF THE GREAT DOMINION: Voices from Forests and Waters, the Settlements and Cities of Canada. Selected and edited by William Douw Lighthall, M.A. Crown 8vo, pp. xxxviii.—465.

A selection of very pleasing poems, divided into the following sections:—I.—The Imperial Spirit. II.—The New Nationality. III.—The Indian. IV.—The Voyageur and Inhabitant. V.—Settlement Life. VI.—Sports and Free Life. VII.—The Spirit of Canadian History. VIII.—Places. IX.—The Seasons.

THE PHONOGRAPHIC AND PRONOUNCING DICTIONARY of the English Language. By Isaac Pitman. Sixth Edition. Crown 8vo, pp. iv.—299. (London: Isaac Pitman & Sons. Bath: Phonetic Institute. 1889.)

This will doubtless prove of great assistance to the student of Phonography; the words are given in the corresponding style of Phonography. By omitting the vowel marks, and by leaving out the endings of all long words (say, after writing three *stroke*-consonants) the writer will obtain the Reporting outline of each word. It appears to contain between 50,000 and 60,000 words, with their Phonographic equivalents.

HEALTH LECTURES FOR THE PEOPLE. Ninth Series. Crown 8vo, pp. 114. (Edinburgh: Macniven and Wallace. 1889.) Price 1s.

A series of five Lectures delivered in Edinburgh during the winter 1888—9; they treat of the following subjects:—Popular Errors in regard to Medicine; How to make Children Healthy and Happy; Thrift in regard to Health and Wealth; Animal Heat, how it is produced, lost, and preserved; Food and Drink, and their relation to the well-being of the People. We notice the word "Illustrated" on title-page, but have failed to find a single illustration.

A NEW SHILLING BOOK OF ALPHABETS. (London: Field and Tuer.)

This book consists of 48 sheets of plain and ornamental letters, including sets of Numerals, and many Decorative Designs for the use of Architects, Clergymen, Decorators, Designers, Draughtsmen, Teachers, and all who have occasion to copy alphabets (capital and small letters), both Ancient and Modern, Plain and Fanciful.

THE CASKET LETTERS, and Mary, Queen of Scots, with Appendices. By T. F. Henderson. Crown 8vo, pp. xii.—193. (Edinburgh: Adam and Charles Black. 1889.)

In this volume an endeavour is made to show that, within recent years, substantial progress has been made towards a definite conclusion of the controversy regarding these letters; great importance is claimed for Morton's Declaration, which is contained in Chapter VII., and further referred to in Appendix A.

DOWN THE GREAT RIVER. By Captain Willard Glazier. Crown 8vo, pp. xxvi.—443. Appendix liii. (Philadelphia: Hubbard Bros. 1889.)

This very interesting book gives an account of the discoveries of the True Source of the Mississippi, with views, descriptive and pictorial, of the cities, towns, villages, and scenery on the banks of the river, as seen during a canoe voyage of over Three Thousand miles from its head waters to the Gulf of Mexico. The book is handsomely bound and nicely illustrated.

Bancroft's Works: History of California. Vol. I. By Hubert Howe Bancroft. 8vo, pp. lxxxviii.—744. (London: Trubner and Co. San Francisco: The History Publishing Co.)

We have before us the first volume of another Section of the works of this great historian. This volume traces the history of California from its discovery in 1542 to 1800. The author gives a long bibliographical list of works consulted, followed by accounts of the discovery of California, the origin of the name, the founding of Missions, etc., the succession of rulers, and the progress of industries, institutions, and events. The amount of research exhibited in the production of these volumes is truly astounding.

Brean Down. Festivals and Events of 200 years ago. By Silver Spur. Crown 8vo, pp. 82. (Bristol: William F. Mack.)

Visitors to Weston-super-Mare will be interested in reading this little book; it contains a short history of many years of events in the locality. There is evidently more meaning than at first sight appears in the account of the family once owning the promontory and other extensive estates, which perhaps time will unravel.

The proposed harbour on Brean Down, the bill for which we believe has been passed, will no doubt add very considerably to the value of the property, and we trust that the unfortunate family, a brief sketch of whose history we have before us, may be benefitted.

The Indians: Their Manners and Customs. By John McLean, M.A., Ph.D. Crown 8vo, pp. 351. (Toronto, Canada: William Briggs. 1889.) Price $1.

Dr. McLean has spent nine years among the Blood Indians of the Canadian North-West, studying their language, customs, mythology, and traditions; he has also collected a good library of books on the Indians, and has studied with enthusiasm among the lodges everything pertaining to the life and labour of the Red Men of the West. He tells us that "the strange life of the dwellers in the lodges, the wonderful mythology and traditions, and the peculiar customs which are peculiarly their own, reveal to us a civilisation which is fascinating, and yet but little understood." There are 18 full-page illustrations.

"Zummerzet" Rhymes. Crown 8vo, pp. vi.—123. (London: Houlston and Sons. Bridgewater: E. T. Page.)

Some very amusing poems in the West Somersetshire dialect. Three authors contribute to these Poems: "Jan." ("O. P. Q. Philander Smiff") writes seven poems, giving incidents in his life; a dozen by "Tommy Nutty," on various subjects; these are followed by others by the late James Jennings.

W. P. Collins' Catalogue of Scientific Books: Cryptogamia. (London: W. P. Collins, 157 Gt. Portland Street. June, 1888.)

A very complete collection of Cryptogamic books is here offered. It appears to contain most of the great Monographs of Ehrenberg, Smith, Schmidt, Van Heurck, etc. etc., to the smallest pamphlets published on the subject. To those desirous of forming a library of Cryptogamic Botany, a good opportunity is now afforded them. We notice also that Mr. Collins is offering two Vols. of "Studies in Microscopical Science," edited by Arthur C. Cole, for two guineas, original price, £4 4s.; and a few copies of the "International Scientist's Directory," 1882, for 2s. 6d., a most useful book, and originally published at five times the amount.

Report as to the Best System for the Maintenance of Main Roads, in the County of Hertford. By Urban A. Smith, County Surveyor of Highways.—Contains information which will doubtless prove useful to surveyors generally.

Microscopical Imagery.

By Dr. Royston-Pigott, M.A., F.R.S.

Plate XX. Part 3.

Brilliant Miniatures and Minute Molecules.
Colias Cosonia.

NATURE produces no more splendid phenomena than those of a minute solar beam of light as emitted by the heliostat alluded to in the last article.

A small plano-convex lens is attached to the sub-stage and centred accurately. The microscope focusses on the solar image. In beauty of form, accuracy of tracery, variety of patterns, and solar glory of colouring, nothing in Nature rivals these phenomena. Their splendour overpowers the observer, who to escape injury hurriedly seizes on any known methods of subduing their intolerable brilliance. Smaller and smaller beams were employed, a lengthened tube, and deeper eyepieces, until the spectacle became bearable. They were then copied so faithfully by a deaf-and-dumb artist as to elicit admiration at a meeting of the Royal Society. A sunlit room assisted their delineation. A very slight obliquity or excentricity of the stage-lens developed strange transformations from circular to conical curves.

So soon as the convex lens regains its true axial position, all these figures become circular. When the focus is changed slightly, the rings either expand or contract. The simple lens being naturally "uncorrected," presents these rings below the best focus; whilst above it they resolve into the mist or fog of spherical aberration. If a miniaturing objective be now substituted for the little stage-lens, these rings, by properly adjusting the screw-collars, may be produced on both sides of the best focus—*i.e.*, beyond it and above it—of very similar appearance. Seen only above it, they denote over-correction; seen only below it, they denote under-correction.

When obliquity is established, rare and most beautiful forms arise, resembling parachutes, vases, or comets, made up of ellipsoid, parabolic, or hyperbolic diffraction lines. These effects depend on the aberrations present and the arrangements of the optical axes. Inaccurate centreing of the objective lenses is at once detected by the production of excentric patterns and more than one central disc; whilst bad curvatures of the glasses produce irregular shapes in the central black rings, and sometimes a variety of spurious discs. At other times, with inferior glasses, the beauty of the rings is entirely marred, very few can be developed, and no black rings at all can be seen.*

These researches point to many difficulties to be encountered under high-power definition, especially in the observation of brilliant organic particles. Thus the molecules seen in the celebrated *Podura* scales baffle almost all observers. Using a fine 1—50th immersion by Powell and Lealand (price 3c guineas; this glass is now charged £80 *apochromatic*) without any obliquity of illumination, but employing a tube shortened four inches and a B eyepiece (power, 1330), the upper and continuous ribs of the *Podura* were resolved into strings of blue sapphire-like beads appearing perfectly circular. The interspaces between the markings, at *a lower focus*, showed subjacent strings of white beads. Monads appeared blue, swimming about in the water-immersion used, and also lying in well-defined masses. Some of them could be seen to rotate. The cilia were invisible, but the movements gave strong indications of them. A blue glass improved the definition (petroleum-oil lamp, $1\frac{1}{2}$-inch objective for condenser, without stops centrally used).

At present, nothing is more difficult of definition in the microscope than an assemblage of minute, refracting, organic particles. Virtually forming discs of light, these evolve the diffraction-errors and phenomena more or less vividly. No English microscopist, so far as is known to the writer, has succeeded in displaying these beautiful beaded structures existing between the celebrated exclamation markings of the *Podura* test-object. Here closely-packed masses of organic particles, highly refractive, transparent, and diffractive, obscure each other; brilliant points are

* For a fuller account, see *Proc. Royal Society*, No. 146, 1873.

swelled out exceedingly, for a theoretical solar disc of one-millionth of an inch appeared as large as a disc the sixty-thousandth (easily formed by placing a minute lens next the heliostat).* To define *accurately* bright organic particles, such as those of the smallest disease-germs or the molecules of cancer-cells, is at present unattainable. When such delicate forms are in quest, all rays of an aberrating character must necessarily be extinguished.

In the *Podura* case noted above, I found the resolution was best accomplished with the 1—50th, when a peculiar blueish-green sunset sky was used to illuminate the beadings ; doubtless, in this case, the diffraction spectra had reached a minimum, whilst the blue light extinguished the aberration of the red rays.

In my experience, minute organic particles are in general translucent, and give out not only diffractive, but aberrative rays, which conspire to over-power the delicate rays due to outline only.

Minute Molecules.

I particularly wish to inform the readers of this Journal, that a new test-scale, more difficult than usual, has been discovered, obtained from the English Butterfly, *Colias Cæsonia ;* every scale is most minutely beaded with molecules, arranged more or less incurved or straight rouleaus. Some of these I have called *coronets.* Mr. Powell has received two slides from me, and sees these minute molecules readily with his Apochromatic oil-1—12th.

The size of the smallest molecules is about 1—140,000th of an inch. The coronets are composed of beaded rings enclosing a small central dot of light. Had I not noticed similar, though larger structures, these coronets would have escaped my attention.

First, I had seen plain rings or circular holes in the intercostal spaces of *Papilio Mavedon.* Secondly, dotted rings similarly distributed in *Papilio Memnon.* Thirdly, rings adorned with one molecule at the circumference can be seen in *Paphia Argynnis.*

The *test-colias* scales are dark, having ribs widely disposed about the 1—100,000th of an inch thick. The chaplets of molecules run chiefly in a longitudinal direction, wavy or linear.

With a fine $\frac{1}{4}$-objective, a minute mottling can be discerned.

* Described in the last paper.

But the glass must be exceptionally good, and the condenser free from aberration, as in a good objective $\frac{1}{2}$ or $\frac{1}{4}$-inch. Daylight succeeds the best.

The *molecules* composing the *coronets* are finer than those of the clothes-moth scale (*Tinea vest*). I first discerned the remarkable rippling on the scales of *Colias* with a fine Hinton * $\frac{1}{4}$-inch objective, price £1 5s. Very few glasses of that power will render anything visible, but an irregular, dim, misty, and ill-defined mottling. I have found green Dammar a good mounting medium, or they can be seen mounted *dry*.

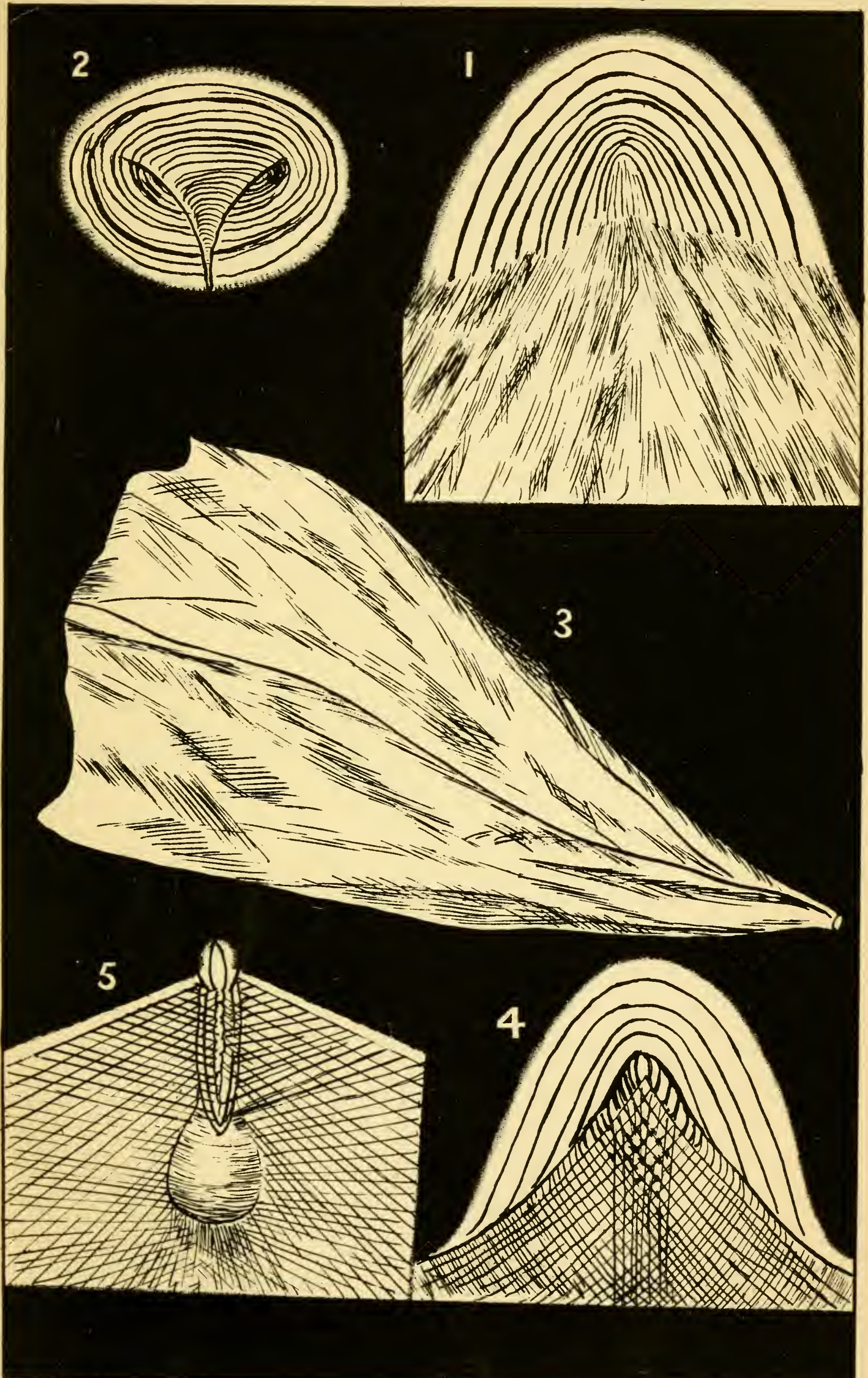
The molecules forming beautifully minute circlets, enclosing a central bright disc, are still smaller, and try the objective quality severely. Their colour is a very deep violet. Chatelains, beaded bars, parallel rows, wavy depositions, and irregular groups, principally distinguish these scales. An immersion condenser of large aperture with direct central daylight, strongly illuminated the field. Perforated mahogany slips mounted with two glass covers allow the condenser to make oil contact with the lower cover, which is 1—60th thick.

The central engraving in the plate represents the dust off a huge Indian Moth, yet one which exhibits almost the smallest molecules known, excepting those of *Colias Cæsonia.* They display black test-rings of great beauty, as well as brilliant focal discs adorned with chromatic tints. Their exceedingly close packings in masses of strata greatly increases the difficulty of their resolution. On shewing it to one of the best London microscopists, he declared it was the most wonderful resolution he had ever seen. The *Colias* possesses indeed much smaller molecules; but as they are tolerably sparse, they can be quite well seen with a very high-class apochromatic, 1—12th oil immersion.

Description of Plate.

The figures in the plate can be developed in an undarkened room with amazing splendour, notwithstanding full sunshine. All the figures, at a power of 1,000 diameters, were seen with a fine Powell and Lealand $\frac{1}{8}$th immersion. Fig. V. shows the

* Mr. Hinton (Vorley Road, Holloway) also supplies *Colias Cæsonia*, beautifully mounted.



Microscopical imagery

lines formed by the solar spectra viewed with the greatest obliquity attainable; the elliptic lines representing a focal plane cutting both sides of the cone of converging rays.

The central drawing was taken from a huge Indian Moth, Fig. III., crowded with minute beading 1—90,000th of an inch in diameter.

(*To be continued.*)

The Development of the Tadpole.

By J. W. Gatehouse, F.I.C.

Part VIII. Plates XXI., XXII.

As the readers of this Journal will probably have discovered for themselves long ere this, the writer of this series of papers can by no means be termed a master of the subject, but must be considered rather in the light of a student trying to observe for himself, and drawing conclusions from these observations made on original sections cut direct from the object studied. Under these circumstances it would be wonderful if he did not fall into mistakes, and if his unknown friends would kindly point out any they may have observed, it would be doing him a real service, as these studies are undertaken as a recreation and change of work from his usual labour.

One such mistake certainly was made in the last article. An observed structure situate over the front of the fourth ventricle, and connected apparently with the branching processes, which ultimately become the chloroid plexus, was termed the pineal gland. A little thought would have prevented this structure, of which the writer can find no account in any description of the amphibian brain at his command, from being called the pineal gland, as that organ is situate much anterior to the observed position of the one partly described, being in fact at the base of the cerebral lobes, and well in front of the optic lobes, instead of behind them. If any one could kindly give him

information as to the nature or name of the structure described, they would confer a great favour upon him. And here, if a suggestion may be permitted, he would ask why the pages of this Magazine should not be made a true vehicle of communication between the members of the Postal Microscopical Society and the readers generally. After this confession of error, which was due to my readers, an attempt shall be made to give an account of my observations on the growth of the limbs of the frog.

All who have ever watched frog-tadpoles, even slightly, must have observed that the hind-legs are apparently produced before the front-limbs. Animals, with beautifully long tails which they use with the utmost freedom and grace in propelling themselves through the water, are seen also to possess two small but complete hind-limbs, which are apparently perfect long before there is any visible trace of the fore-legs. Thus, with respect to a set of animals which were carefully watched, the hind-legs were well out on June 4th, but the fore-limbs were not seen till eight days later, or on June 12th, and by the 22nd of the month the tail had nearly disappeared.

Now comes a most critical period in the life of these little creatures. When just in this stage of what may be termed half fish and half frog, should the conditions of existence be the least unfavourable, they die off most rapidly, so that out of a large colony not one will remain. Deep water, with no resting place on the top, is absolutely fatal. The creature now requires atmospheric air at short intervals, and should be placed either in a shallow vessel or in a tank where it can rest on substances placed just under the surface of the water, so as to keep its body moist, whilst its nostrils may be readily raised out of the water, and even under these circumstances they will all disappear in a few days, hopping off to damp grass, there to hide during the day in any shady nook, and at night swarming forth in such numbers, especially after a slight shower, as to make many people believe in showers of frogs.

As then the hind-legs are the first to shew themselves, our observations shall first apply to them, but in truth the front-legs are growing at the same time, the only difference being that these are hidden from sight, whilst those are to be seen almost from the

first. Carrying back our observations from the fully-developed structures to the earliest date at which any trace of the limbs can be detected, we find that about a month after the eggs are deposited it is possible to detect the first traces of these appendages. At this period, when the external gills are still active and the alimentary canal has not been fully formed, but the proctodeum and lower portion of the intestine can be plainly seen (see Figs. 1, 2, and 3, Plate XIII., July number, 1888), there, in the angle formed between the immature tail and the external opening of the alimentary canal, can be seen a few dark-coloured cells of large size, having a very large and conspicuous whitish nucleus, very different to all the surrounding cells. These cells are portions of the epidermis, which afterwards divides into the true skin and the ectoderm, but which, at the period named, March 23rd to 25th, is homogeneous, being, however, much lighter in the district pointed out and around the tail than it is on the fore part of the body. A diagram of these cells can be seen in Figs. 1, 1*a*, Plate XXI., of this part.

It must be remembered that at this period of growth the development and alteration of all parts is most rapid, and in the course of a few days there is a distinct separation between the skin and the ectoderm, and at the hinder part of the abdomen this occurs to the greatest extent, so that by April 1st, when the lower portion of the intestine has extended far beyond the general line of the abdominal curve, there is quite a large space separating the ectoderm from the skin at this point. By the term large space must not be understood a vacuous space. It is, indeed, filled with a most delicate structure, including many multipolar cells, and others, looking like muscle cells, of an elongated lozenge shape, distinctly nucleated, and much attenuated. The upper boundary of this structure consists of the skin muscles, which run all down the abdomen, extend into the tail, and there unite with the great mass of tail muscles which cover the spinal cord and notochord.

It is within the space thus bounded by true skin and ectoderm that the hind-limbs begin to grow, forming a small protuberance, consisting, at first, of a few cells, pushing the ectoderm outwards. The external wall is much thicker just over the protuberance than in other parts of the ectoderm, consisting of two layers, the outer being much the darker of the two. This protuberance, once

formed, grows rapidly, pushing the ectoderm in front of it, till in about a month (April 30th) it has formed quite a pouch on either side of the protruded intestine, immediately beneath the tail. These pouches, filled with closely packed dividing cells, have exactly the appearance of two small egg-bags, reminding one very forcibly of the egg-packets attached to the tails of some crustaceans. At this early period there is not much difference to be observed in the character or form of the cells of which these pouches are composed, with the exception that possibly the outer layers of cells are smaller than the inner.

The sac is composed of two layers of cells, the innermost consisting of a cubical layer. At the extreme end of this pouch there soon commences to be observed a difference in the character of the cell layers, larger cells appearing there than elsewhere, and thus, appears to me, commences to be produced that wonderful complexity of muscle and nerve, tendon, bone, and cartilage, which we term the leg. These pouches are, thus far, perfectly oval below, shewing no signs of any inequality; but from the large cells, just mentioned, pushing outwards unequally, the lower portion becomes somewhat crenate, or broken up into small irregular knobs, and at the same time points of ossification can be observed in three or four distinct centres, notably in the thigh and carpus, as shewn in Figs. 4, 5, 6, Pl. XXII. Around these centres of bone formation the cells arrange themselves, lengthening out to form muscles. The general form of the leg can be well made out by the middle of May, very short and immature certainly, but yet a leg to all intents and purposes, if no use yet either for swimming or jumping, in both which accomplishments the mature animal is so proficient, but yet a leg so fairly formed, that my little son, who has just looked into the microscope, exclaims, "Oh! there's a leg. I can see it with my eye."

One point, however, about this leg is that I can only find four toes instead of the five, which the animal ultimately possesses; three fairly well formed, and the fourth just visible, but whether it is that my sections will not permit me to see the fifth protuberance, or that in reality it is not there, and thus cannot be seen, I am not sure, but incline to the latter explanation. I speak of toes, but in reality they are only distinct protuberances on the growing leg.

The web, however, soon becomes plainly visible, and is seen to consist of portions of the ectoderm, which remain thinned out and unabsorbed. This is apparently the true explanation of its transparency; not being derived from the true skin it never becomes so crowded with colour cells as is the case with that structure.

Although by the end of May it is quite easy to make out the shape of the leg-bone, and even to see the form of the head of the femur; it is not possible at this date to make out the bones of the pubis, which soon afterwards become so prominent a feature in horizontal sections (Fig. 7, Pl. XXII.). There are certainly two points of ossification to be seen just outside the inner portion of the head of the femur, and as many of the muscle-cells from the leg appear to coalesce and terminate at these points, they must be considered as the representatives of the pelvic bones at this stage. The leg, as a whole, is, however, at this period not articulated to any portion of the vertebral column, but is attached above to the true abdominal muscles of the skin, whilst the skin on the outside of the thigh is a continuation of the ectoderm, and that on the inside is connected with that portion of the intestine which protrudes beyond the general contour of the abdomen. At this date also the five toes are distinctly visible, the three inner ones, which were the first to form, being much larger than the two outer. At this period the leg-bone, *os cruris*, as it is afterwards called, can be distinctly seen to be composed of two bones, the tibia and fibula, which are separate throughout the greater part of their length, merely touching at the articulations.

The warm weather of June appears to exercise a wonderful influence on the rapidity of development; the tail begins to be absorbed, and as this goes on the true vertebral column can be seen in course of formation, and, indeed, the animal now appears to actually live upon its tail. It certainly eats but little, if at all, during this period of tail absorption, and in order to determine the gain or loss of weight, certain animals were carefully weighed on various days. Thus, an animal with tail half absorbed weighed 3·3 grains; the same with tail nearly absorbed weighed only 2·6 grains, and although the following determinations were made on an animal about a month later they all give the same history. Thus, weight on July 12th, 4·51 grains; on July 17th,

3·13 grains; on July 19th, 2·8 grains; on July 24th, 2·75 grains; and on July 26th, 2·6 grains. In this case the loss was enormous, and finding that the little creature which I had watched so carefully for many months was daily losing flesh because it could not find foot to eat in my place, and having now become a perfect frog I took what I conceived to be the most humane course, and turned it out to grass, losing sight of it for ever.

To return, however, to the development of the limbs. By the end of the first week in June the bones of the pelvis are seen to be well formed, portions of them being shewn in Fig. 7, Pl. XXII. A transverse section, of June 10th, shews also that the long thin bone, called the urostyle, attached in front to the vertebral column and behind by means of cartilage to the pubis, has also commenced to form. It must not, however, be supposed that these structures are yet true bone. They are merely cartilage, or if bone at all, then so soft as not to injure the edge of a keen razor whilst cutting. The bones of the head appear in a much higher state of development, and offer a distinct resistance in cutting. By the beginning of July many animals were outwardly perfect frogs, and sections taken at this period through the whole animal present a most ludicrous appearance on the slide, looking very like a miniature caricature of the human body. In these the muscles, with their attachments to the bones, are beautifully seen. Some of them in the hind-limbs I have tried to delineate in the plate. On the slide each muscle fibre stands out distinct and clear, many of them yet unstriated, but each muscle distinct from the rest, ultimately connected with its own special portion of the periosteum, now seen as a very fibrous structure. The bone-cells now consist of two kinds—(1) Large cells, with small nuclei; (2) Small cells, with comparatively large nuclei. The former constitute the mass of the bone, whilst the latter form the articulations. Here they appear to be interpenetrated by the fibrous periosteum, which may possibly account for the property of articular cartilage splitting up vertically. The under portion of the skin of the thigh is only very loosely attached to the muscles beneath, and is supported mainly by a fibrous attachment, which connects it with the point of the pubis.

As previously mentioned, the development of the fore-limb

commences about the same time as that of the hind-leg, and proceeds equally with it, although the front-legs themselves are hidden under the skin for some time, breaking out at about the same time as the hind-legs are capable of useful motion.

As in the hind-limb, so in the fore, the first visible sign of structure consists in the formation of a protuberance, which, however, instead of growing outwards, increases in length inwards, and ultimately almost fills a cavity contained under the skin in the region of the lungs. The abdominal region here extends outwards to so great an extent that, proceeding upwards from the outer skin of the abdomen, each section, upwards to the middle plane of the lungs, is found to be quite surrounded by a layer of skin, thus giving the false appearance of a diaphragm stretching between the abdominal and thoracic regions.

Before the deposition of colour-cells in the skin, so deceptive is this appearance, that it requires some amount of thought to dispossess one's mind of the idea of a true diaphragm, instead of merely the false appearance of one. The first change of the protuberance into an arm is seen in the formation of a joint almost close to the skin by the production of two transverse layers of cells proceeding from the outer covering of the protuberance. The outer layer, of somewhat elongated cells, bends first outwards and next inwards across the whole width of the protuberance, thus dividing it into two parts: a very short proximal and a much longer distal one, which is in every part surrounded by the inner layer of cells forming the covering. The thicker middle layer, between these two, bends round also, so as to form a kind of division between these two transverse layers (see Fig. 8, Pl. XXII., and Fig. 9, Pl. XXII.).

Much acute speculation has been spent on the homologies existing between, and derivation of, the vertebrate limb from the fin of the fish. It is impossible for me to express any opinion on either of these theories, except to make the bare statement that whatever may have happened in past ages, at the present time we never find a fœtal fin or ichthyopterygium becoming a vertebrate hand or cheiropterygium, nor do we find in the two structures such analogous and close agreement in detail, or, indeed, apparently in development, as would be likely to impress different observers with similar ideas as to their close identity.

In the words of Balfour—" The gulf between the two types of limbs is so great that there is room for a very great diversity of opinion as to the mode of evolution of the cheiropterygium." Gegenbaur, Huxley, Gotte, and Balfour all differ seriously from each other in their explanation of this question of evolution, the only point on which they appear to agree being in the statement that undoubtedly, in some way or other, not easy to be explained, the fore-limb of vertebrates was evolved from the fin of a fish. Why not the reverse? appears to me to be a question quite as difficult to answer.

EXPLANATION OF PLATES XXI., XXII.

The whole of the figures on these plates illustrate the development of the limbs of the Frog, from their earliest stage to the period at which they become functionally active.

Plate XXI.

Fig. 1.—Shows the posterior portion of the body of a Tadpole on March 23rd, about a month after laying, with a few cells in the ectoderm from which the leg is developed.

,, 1*a*.—Some of the same cells on a larger scale.

,, 2 and 2*a*.—The same, a week later, shewing the connection between the muscles of the tail and those of the abdomen.

,, 3.—The whole animal, shewing the position of the fore and hind legs at a more advanced stage.

,, 3*a*.—The hind leg, *h.l.*, of Fig. 3 more highly magnified, shewing the commencement of the formation of the pigment cells.

Plate XXII.

,, 4, 5, 6.—Hind legs in further stages of development, shewing points of ossification and the commencement of the formation of muscle.

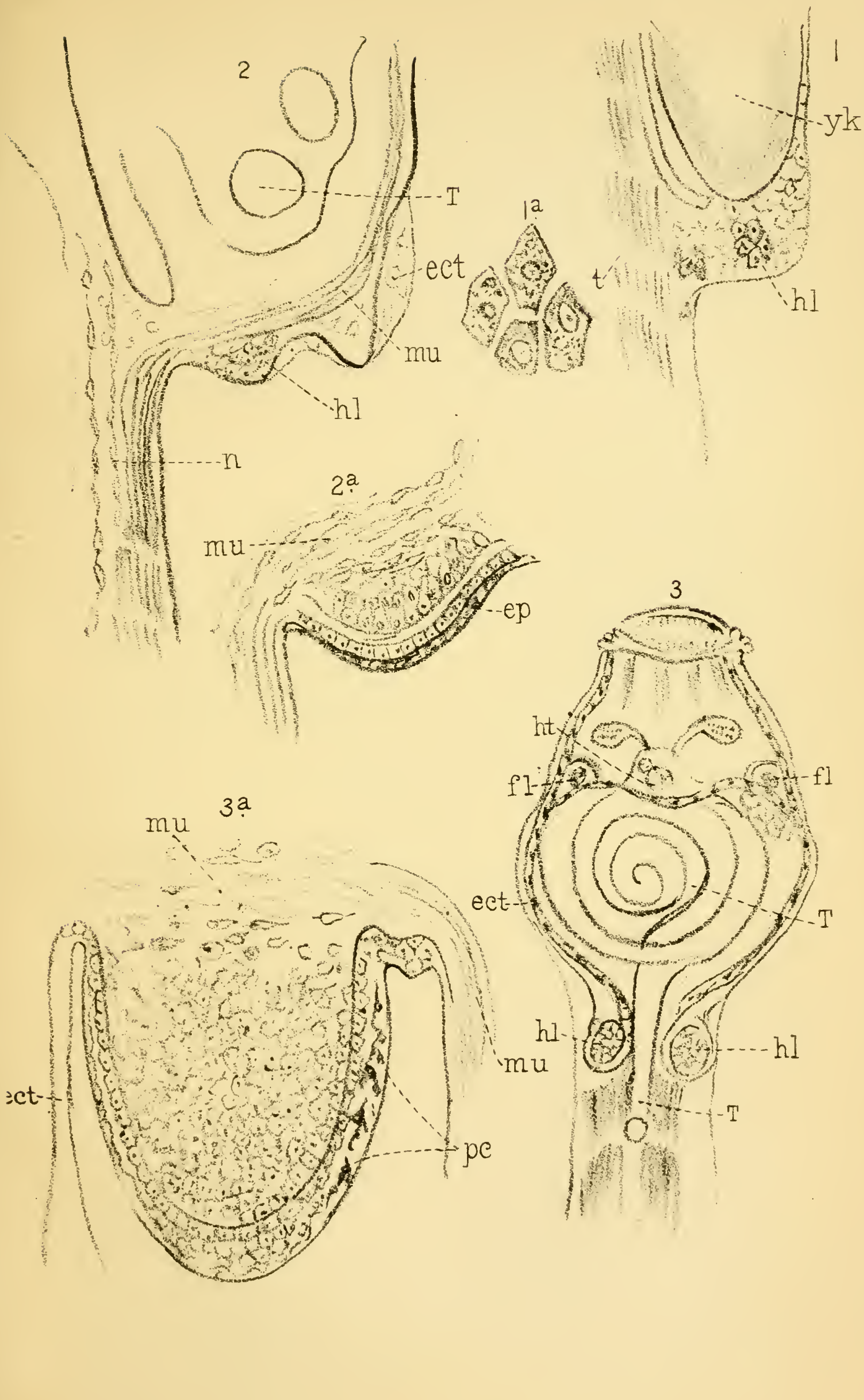
,, 7.—Hind legs fully developed, shewing bones with their attachment, position of the urostyle, with the acetabulum, and the principal muscles. Date, July 4th.

,, 8.—Fore leg at same date as hind leg, 3*a*.

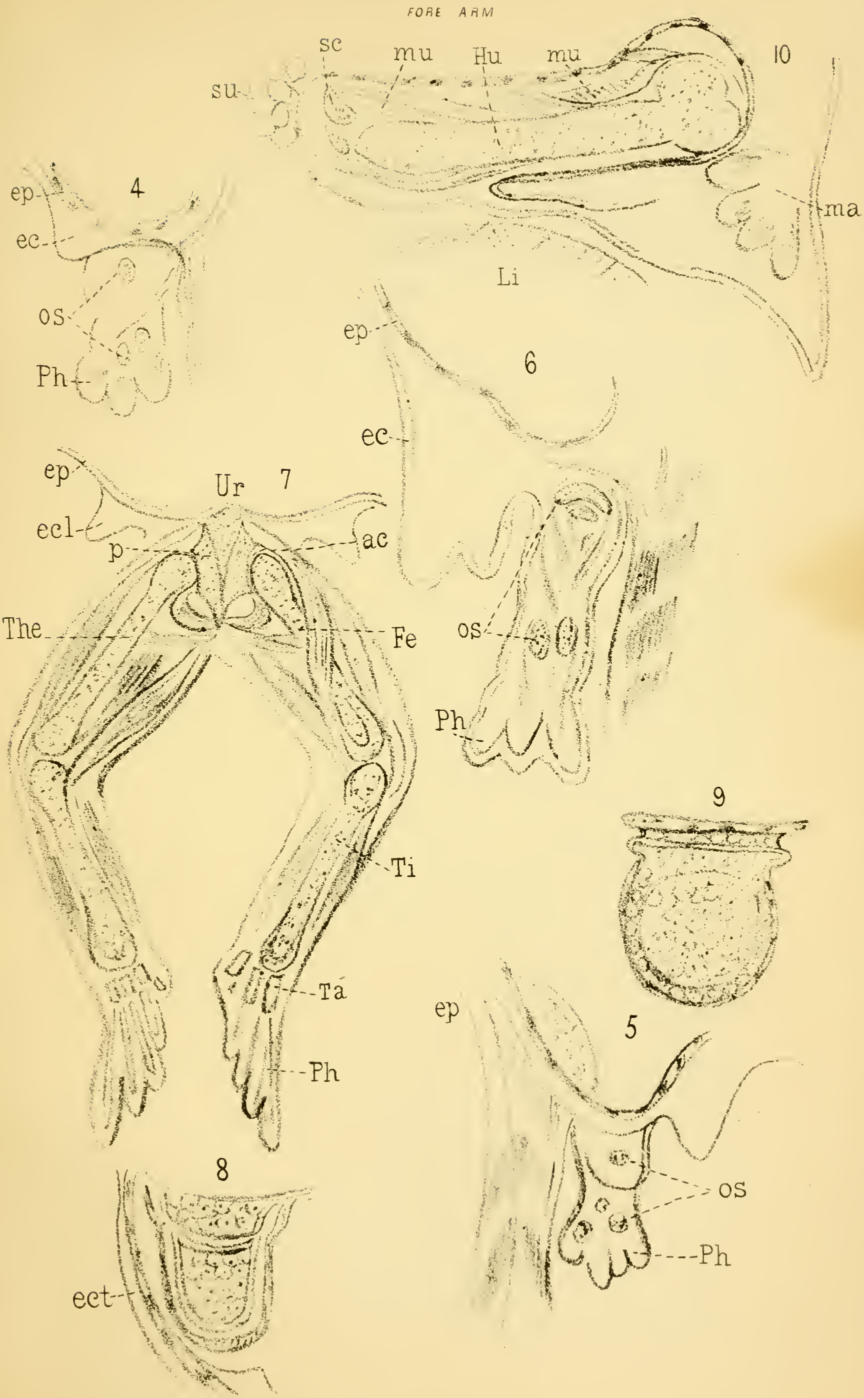
,, 9.—Ditto, slightly more developed.

,, 10.—Ditto, nearly developed, but not yet extruded beyond the skin.

yk., yelk.
i., intestines.
h.l., hind leg.
t., tail.
hu., humerus.
mu., muscles.
n., notochord.
ep., epidermis.
ti., tibia.
p., pubis.
p.c., pigment cells.
ect., ectoderm.
sc., scapula.
fl., fore-leg.
ph., phlanges.
fe., femur.
ma., manus.
os., points of ossification.
ac., acetabulum.
ta., tarsus.



Development of Tadpole



Development of Tadpole.

Practical Notes on Histology.

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Special Methods for Examination of the Eye.

To study the eye is one of the most difficult organs in this work, it is so easily destroyed, difficult to manipulate to the best advantage, requiring much judgment, care, and patience. If possible, the human eye should be used, for there are some slight differences in the structure of some of the parts of the eye in man and animals, and moreover it is, I think, easier to demonstrate this in the human eye. It is essential to obtain it in a perfectly fresh condition, and on this account the difficulty is increased.

Of the lower animals, the eyes of the pig and frog are best for minute structure, especially the retina. For a general preservative I use Müller's fluid, and when hardened wash well in water, and then place in 2 parts spirit and 1 part water ; after one or two days, not longer, place the eye in pure spirit till wanted. Another way is, as soon after removal as possible, to separate the eye, by an oblique cut with a very sharp knife or razor, into two halves—an anterior and a posterior. The cut to start from must commence just behind the attachment of the iris anteriorly and superiorly, and pass downwards and backwards towards the posterior part of the organ, coming out a little below the yellow spot and optic nerve. Then place the posterior part, after allowing the vitreous humour to fall away from the retina, into a 2 per cent. solution of osmic acid and the anterior part in Müller's fluid. The cornea is to be cut through at one place with a sharp scalpel, so that the preservative fluid may get freely into the anterior chamber. The piece in osmic acid is left there for eight hours, then placed in water for two hours, and finally transferred to a mixture of equal parts of glycerine, alcohol, and water. In this it is to remain for a week or more, until wanted. The specimens must *not* be handled more than can be helped.

The Eye-lids.—Make sections of the hardened lid across its long axis and vertically to its surfaces. It is hardened in spirit or Müller embedded, cut, and the sections stained with logwood, log-

wood and eosin, or logwood and picro-carmine, and mounted in Canada balsam.

Lachrymal Gland can be hardened in alcohol. One-sixth per cent. chromic acid, or a mixture of spirit and a half per cent. solution of chromic acid, equal parts of each; and in a day or two place in spirit. Osmic acid, one-fourth per cent., is a good hardening agent, and small pieces should be teased in glycerine and mounted.

Sclerotic.—Agents :—Either spirit, Müller's fluid, or chromic acid, one-sixth per cent., of which take 2 parts, and spirit 1 part. Stain in logwood and picro-carmine and mount.

Tenon's Capsule.—Take a fresh eye and remove all the adhering mass of tissue except the eye-muscles, leaving the loose connective tissue. The eye thus cleared is rinsed in distilled water and a few drops of nitrate of silver solution poured over the posterior part. After about three minutes rinse off the silver by a stream of distilled water, and place the eye in water in the sun. When stained, remove and fasten under water to a loaded cork by a long pin passed through the cornea, and a piece of the capsule of Tenon is dissected off the globe, floated flat on to a slide, and removed from the fluid. After the excess of water has been got rid of, the piece is covered by glycerine, and examined for the epithelioid markings.

Lamina fusca.—The epithelioid layer lining the Lamina fusca is also prepared by nitrate of silver. Dissect a square piece of the sclerotic from a fresh eye; the convex outer surface of it is then pressed and made concave, dip in distilled water, silver solution two minutes, rinse in distilled water, transfer to spirit, place in sunlight with the inner surface, or Lamina fusca, uppermost. When stained brown, place in water, wash well, and mount in glycerine. The Lamina fusca may be seen in eyes prepared in Müller's fluid. Pin a small piece of the sclerotic under weak spirit, equal parts water and spirit, dissect off the Lamina fusca from its inner surface, and float on to a slide; allow the spirit to evaporate, so as to leave the delicate membrane moistened only with water. Cover the preparation and add a little glycerine to the edge of the cover-glass.

The Choroid is best prepared from an eye hardened in Müller's fluid. Besides the main substance of the coat containing the larger blood-vessels, the lamina supra-choroidea, the chorio-capillaries, and the membrane of Bruch, should be separately displayed. The posterior attachment of the fibres of the ciliary muscle, and the gangliated plexus of nerves which is found in the neighbourhood of its posterior attachment, will be exhibited with the lamina supra-choroidea.

Ciliary Muscle and Lamina supra-choroidea.—Divide the eye-ball of an ox, sheep, or pig, with a sharp razor, transversely, half inch behind the circumference of the cornea, and remove the lens, but be careful to retain the choroid and iris. Harden the anterior half in chromic acid and spirit. Make horizontal sections to include the sclerotic, cornea, and the iris. Stain with logwood and picro-carmine ; or the anterior part of the eye may be pinned under spirit, and the sclerotic and cornea cut away at one part, when the radiating fibres of the ciliary muscle will be seen passing meridionally from their origin opposite the attachment of the iris, and forming a layer which becomes gradually thinner as it extends backwards, and finally ceases in the superficial part of the choroid. Seize with fine forceps a small piece of the muscle near its origin, and carrying the instrument slowly backwards, it is gradually torn away from the rest. It will be found that the shred which comes away generally spreads out posteriorly into a very thin membranous lamina, which is, in fact, a piece of the lamina supra-choroidea, into which the superficial fibres of the ciliary muscle are inserted. This may be floated directly on to a slide, which is dipped for the purpose into the spirit, wipe off quickly the surplus, and drop some freshly filtered logwood upon the tissue, and allow to remain on it for ten minutes ; pour off the stain and run off the remains by allowing a drop or two of water to flow gently over, without disturbing the position of the membrane. Finally, the cover-glass is to be laid on, and a drop of glycerine allowed to run at its edge.

Vascular Layers of Choroid and Membrane of Bruch.—These are more difficult to separate than the Lamina supra-choroidea, though it is not absolutely necessary to completely separate them

into distinct membranes. Before separating, the hexagonal pigment cells which belong to the retina, but frequently adhere to the inner surface of the choroid, must be entirely washed off with a *camel-hair pencil* under spirit, and with the aid of a dissecting-lens.

The Musculature of the Iris.—The circular and radiating plain muscular fibres of the iris may be demonstrated in the albino rabbit. Cut the eye in half, and place the anterior part in spirit for a day or more. Remove the lens and cut out a segment of the iris, including its whole width, from the pupillary aperture to the ciliary processes of the choroid, and place in dilute logwood. Do not let it be too deeply stained, then place in water, pass through spirit and clove oil, and mount in dammar or balsam, with the posterior surface uppermost. The thick ring of the sphincter is easily seen in these preparations, and also the interlacing bundles of plain muscular fibre, of which the dilator is composed.

The Iris.—It is useful to prepare the human iris, although difficult on account of the uveal pigment, for the musculature is somewhat different. Take an eye hardened in Müller or bichromate of potash two per cent., and subsequently in spirit. Cut out a piece as before, and treat similarly, except that before staining the pigment is brushed completely off the posterior surface with a stiff camel's-hair brush under spirit. Examine the iris every now and then with a low power, and see when all the pigment is removed. Another way to show the Musculus Dilatator Pupillæ is to excise the iris and place it in strong acetic acid twelve hours, or several days, in a weak solution. It is removed, brushed with a soft brush, and carefully *split* with the point of a scalpel. Then the anterior surface can be removed from the posterior surface of the connective tissue and layer of blood-vessels. The remaining layer of the iris so prepared is now stained with carmine, logwood, or picro-carmine, and mounted in acidulated and diluted glycerine if in the first instance. The following reagents are useful in making the iris denser and more easy to split:—Chromic acid, 0·01 per cent.; gold chloride, 0·1 per cent.; palladium chloride. The smooth muscle-fibres may be stained by putting them for some hours

in strong acetic acid, and then staining with an acid mixture of carmine and glycerine.

The Lens and Vitreous Humour.—To obtain isolated fibres of the lens, take the fresh eye of any animal, and cut it across into anterior and posterior halves. Place the anterior part, having removed the remains of the vitreous humour, in one-eighth per cent. solution of bichromate of potash. Then scratch through the posterior capsule, which is readily ruptured and curls away from the lens proper. Shell this out and leave in the fluid, the remainder of the eye being rejected. The lens is allowed to remain in the bichromate for two or three days, turning over once or twice. It will be found that it has a tendency to separate along the radiating lines which mark the planes of junction of the ends of the fibres, and if a piece of these lamellæ is taken up with the forceps it will tear in the direction of the fibres from one of the planes of junction; separate the fibres with needles in a drop of the bichromate solution. In eyes prepared in Müller the lens will be hardened enough to freeze and cut. Stain in eosin, carmine, or logwood, and mount in glycerine or Canada balsam. Frogs or the codfish show the serrations the best. The anterior epithelium may be shown also by staining the fresh lens in silver nitrate and shaving off a thin layer from the anterior surface, or in a solution of 1 part of fuming nitric acid in 3 parts water and 1 part glycerine. Remove after twenty-four hours and allow to remain a day in water. Tease a portion of the lens in glycerine, and mount in Farrant or glycerine.

Formic Acid (sp. gr., 1,020).—Place the lens in sufficient of the acid to cover it, remove portions from its surface by needles (say, in half-an-hour), tease in a drop of glycerine, or, better, a drop of picric acid, and examine in glycerine. If allowed to stay for twenty-four hours in the acid, the fibres will be in a perfect condition. A mixture of formic acid (sp. gr., 1,020) and water, equal parts, isolates the fibres, but causes them to swell. They may also be isolated rapidly with a saturated solution of caustic potash, and the lens is then found to be in layers.

If the lens is placed in a sky-blue solution of sulphate of copper for eight or ten days, sections can be made in which the

mosaic of the cut fibres is visible. Hydrochloric acid (0·1 to 1 per cent.) may also be used. The capsule can be seen in fresh, but better in preparations stained with purpurine or aniline; and cells on the posterior surface of the anterior segment of the capsule by gold preparations or the aniline stains. Silver nitrate, one-half per cent., will also bring them out well. To best show the surfaces of the lens fibres covered by narrow, elongated cells, take the lens of a toad, which is removed fresh, and placed at once in one-half per cent. of gold solution, in which break it into fragments with needles. Let them remain for thirty minutes, exposed to sunlight, in 2 per cent. acetic acid for several days or until they acquire a dark colour. Examine in glycerine. If the eyeball is injected through the aorta with a quarter per cent. solution of gold, kept tense for some minutes, the cells *may* be fixed *in sitû.* Then stain some fragments of the lens in a concentrated solution of logwood and examine in glycerine. Similar preparations can be obtained by injecting the aorta or carotid of the rat or rabbit.

Zonule of Zinn and the Hyaloid Membrane of the Vitreous Humour.—Take the anterior half of the eye (preserved in spirit) of an albino rabbit, pin the cornea downwards, remove under spirit the remains of the vitreous humour, gently seize the lens with fine forceps, and draw it away from the iris. In so doing, you draw with it the suspensory ligament, the zonule of Zinn, and the part of the hyaloid membrane continuous with this, so that the separated lens appears girdled by a delicate, somewhat crumpled-looking, membranous zone. Cut out with scissors a segment of the zone, and with a section-lifter transfer the piece so removed (it should include its whole breadth) to logwood. Wash in water, float on a slip, and replace the water by glycerine, or instead mount as usual in Canada balsam.

The Retina.—For general use, Müller's fluid is good; but it causes the retina to become brittle. It, however, shows the nervous structure best. Chromic-acid mixture renders it more tough and shows the connective tissue. Good sections are obtained by DOUBLE-STAINING the whole eye of the frog. Place, first, in a strong solution of rosanilin until it is deeply stained, and wash

away the superfluous stain in spirit. Next place the eye for a short time in a strong solution of iodine-green and wash it well; soak in gum solution and freeze. The granular layers are stained green, the others with rosein. Mount in Canada balsam, and do not leave *long* in spirit.

Osmic Acid may also be used as a hardening agent, finally placing it in spirit. It is as well in many cases to stain the tissue first (using logwood, etc.), transfer from the stain to spirit, then embed in wax mass. It is best to place it in the tray in such a way that the sections shall be both vertical and meridional, so that we take in the general course of the fibres of the optic nerve. Mount a few of the thinnest—they *cannot* be too thin—in glycerine; the others transfer to clove oil and then balsam. In the *Osmic* method cut open the bulb, and place the retina, or a part of it, in a 2 per cent. solution of the acid. Leave for several hours, wash *well* in distilled water, and then transfer to alcoholic logwood (Kleinenberg's). Place from it into strong spirit, where it is left till wanted. They may be mounted, some in glycerine and some in a saturated solution of acetate of potash.

Isolation of the Retinal Elements.—Try, first, a piece taken from a 2 per cent. osmic acid solution; wash well and allow to macerate for a few days in a mixture of glycerine, alcohol, and water (glycerine 1 part, alcohol 1 part, water 2 parts); after which a minute portion is to be carefully broken up with fine needles in a drop of weak glycerine, and then replace with pure glycerine. Put other *fresh* portions of retina, one in one-eighth per cent. bichromate of potash for a week, and another in 10 per cent. chloral hydrate for two or three days. Tease out in their respective solutions, and avoid pressure by placing a hair under the cover-glass. These preparations unfortunately will deteriorate.

The retina ought also to be examined in a fresh, unaltered condition. So take a small piece while warm and break up, rapidly and finely as possible, in a drop of serum or vitreous humour. The hexagonal pigment is seen in those hardened in Müller. The retina in the lower vertebrata and in fish, birds, etc., should be teased out fresh in vitreous humour.

An aqueous solution of aniline blue gives good results, as does

a double stain of aniline blue and eosine, where the ganglion-cells are to be seen. Those eyes, fixed in alcohol and preserved in glycerine, keep well, such as kittens or frogs.

Retina of Triton.—Expose to osmium vapour, divide by an equatorial incision, and put the posterior pole for a few hours into an aqueous mixture of one-third alcohol. Stain for some hours in picro-carmine (1 to 100); treat again with osmic acid to fix the elements. Wash in water and harden in alcohol. Imbed in oil and wax, cut sections, and mount in glycerine.

Cornea.—First cut sections and study those made vertically to its surfaces. Use the anterior part of the eye. Harden in Müller and chromic acid mixture, or 2 per cent. bichromate of potash. (It is well to remove the lens to allow the fluid to penetrate freely to the posterior surface of the cornea.) Cut and stain, and mount as usual.

Epithelium, covering the front of the cornea, must be studied in teased preparations, which is done by placing in a drop of distilled water on a slide. Stain in logwood, picro-carmine, or gentian-voilet and mount in glycerine, all to be done on the slide. The glycerine can be easily made to replace the logwood solution, or by Klein's gold method.

The **Substantia propria** is seen by teasing out a fresh cornea, or one macerated in a weak solution of bichromate of potash or in picric acid, or it may be seen in gold preparations of the nerves.

Corpuscles and Nerves in Frog's Cornea.—Destroy the brain and spinal cord, hold the *membrana nictitans* with the forceps, and remove it entirely. The animal is then taken and held in the operator's left hand, press the thumb upwards under the lower jaw, to cause the protrusion of the eye. Insert the scissor-blades into the globe of the eye just behind the insertion of the yellowish iris. Remove the anterior part and place in salt solution in a watch-glass. Pour off the salt solution, leaving just enough for the cornea to float in. Fill up the watch-glass with $\frac{1}{2}$ per cent. solution of gold chloride. Leave for half-an-hour, place in acidulated water (acetic acid), and deposit in a warm place in

the sunlight. Change the fluid after two days, and add one drachm of methylated spirit or alcohol to prevent mildew. Place after another two days in distilled water, and scrape off the epithelium. Change the water to get rid of *débris;* next separate the cornea into two, three, or more lamellæ. Float on a slip, add cover-glass, and run in glycerine. The rabbit's cornea may be prepared as above for nerve preparations.

Isolation of Corneal Corpuscles.—Stain corneal corpuscles with gold; then dissolve away the intermediate substance by caustic alkali, the action of which must be arrested before the corpuscles and nerves are destroyed. This is done by divesting it of epithelium in a watch-glass containing a strong (20 per cent.) solution of caustic potash or soda, and this is then put into a warm chamber at 40 deg. C, 104 deg. F. After three-quarters of an hour the tissue, which is now quite soft and pulpy, is removed with a section-lifter, and placed in a vessel containing a large quantity of water faintly acidulated with acetic acid. Then mount in glycerine.

Cell-Spaces of the Cornea.—These are shown by two methods: —(*a*) The cornea, after the epithelium has been scraped off the front, is rubbed with a stick of fused nitrate of silver (lunar caustic). After five minutes wash the surface with a stream of distilled water from a wash-bottle. The head is now cut off and placed in spirit in the light for a time varying from a few minutes to an hour. When it is brown, remove and leave in a dark place for twenty-four hours. Slice off the cornea, place in water, slit in a triradiate manner, so that it may lie flat on the slide, and mount in glycerine.

(*b*) To inject the cell-spaces, take the eye of any animal, make a solution of alkanet in turpentine, and fill the tube and fine steel canula; insert obliquely into the substance of the cornea, but avoid passing the point into the anterior chamber. The pressure of the mercurial apparatus is gradually raised to about two inches of Hg. (mercury), when the red fluid gradually fills the cell-spaces.

To examine the Nuclei of the Cornea.—Place the entire eye of a rat in half per cent. gold solution for half-an-hour, then for several days in weakly acidulated water, excise, and stain it in

logwood, and examine. Or inject quarter per cent. gold solution from the aorta or carotid of a young rabbit, until the eyeball is tense ; after half-an-hour cut it out and place for a day in acidulated water, then excise the cornea, and examine in glycerine.

General Method.—Place the whole eye in Müller's fluid for three to four weeks, cut with a sharp knife into anterior and posterior halves, wash well in water to remove the yellow colour. The decoloration is hastened by placing them for several minutes in a one per cent. solution of chloral, then for a day in alcohol, then to absolute alcohol for twenty four hours. Then place for twenty-four hours in celloidin dissolved in equal parts of sulpholine, ether, and absolute alcohol; lay in a paper box, fill up with the celloidin solution, and when this has become changed into a gelatinous, elastic mass, put into alcohol (seventy to eighty per cent.), in which it becomes hard and can be preserved indefinitely. Cut beneath alcohol or flood the knife, stain in logwood, wash well in water, clarify in oil of bergamot, and mount in balsam.

Preparing Eyes of Gasteropods.—Use a concentrated solution of perchloride of mercury, which keeps the rods in a good condition for hardening in Müller's fluid ; picric acid or alcohol may be used. It is best to stain in logwood ; first *over*stain, decolorise with a weak solution of alum for a period of several hours to some days. Nuclei and cell show well. Cut in paraffin. For macerating use a two or three per cent. solution of chromate of potash, or it may be concentrated and diluted with a weak oxalic acid solution, or Müller's fluid. Fresh material can be examined in a few days, but hardening takes a few weeks. It is advised to dissociate the macerated and stained specimens when in section, and to separate its elements by tapping on a cover glass.

The Entire Eye.—Remove *directly* after death. Open by a short incision through the sclerotic, midway between the cornea and the entrance of the optic nerve, and then place in some hardening fluid, as before stated. Much depends on the care taken in hardening and fixing. In chromic acid solutions, which are very good, there are two important objections to their indiscriminate use as fixing and hardening agents :—(1) They

render the lens brittle and too hard, and often the sections are difficult to stain. This can be done by placing the eye in a 2 per cent. watery solution of carbolic acid for a week, and should then be transferred to alcohol and treated as usual. If sections are required without a lens, use chromic acid solution. The eye is best stained in bulk, though not absolutely necessary. Before placing in the stain four small openings should be made in it: two in the anterior chamber and two in the vitreous. The former should be situated opposite to one another, at the periphery; the others opposite one another, and situated midway between the cornea and the entrance of the optic nerve. I believe the best *reliable* stain for bulk is borax carmine (alcoholic). Kleinenberg's logwood penetrates sufficiently, but often fails to select. Dr. H. Gibbes' logwood, given in April number of *The Microscope*, 1889, seems so far, if used in a weak solution, to act *well.* Most of the anilines stain and penetrate admirably, but are partially removed during the necessary after-treatment. The eye should be left in the stain for from two to four days, according to the rapidity with which it stains. The staining is sometimes diffuse, and it is therefore preferable in some cases to place the eye, after staining, in alcohol, containing a trace of hydrochloric acid, in order to remove the stain from everything but the nuclei. For alcoholic borax carmine (Woodward's) take carmine, 15 grains; borax, 1 drachm; water to make 8 ounces. Dissolve by warming and slowly evaporating to 4 ounces; now add 7 ounces of alcohol. If used in bulk, there is no need to filter it. Shake well from time to time. When the eye is stained wash it, and transfer it to alcohol, and then to a mixture of equal parts alcohol and ether. In this mixture leave the eye for twenty-four hours, when it should be transferred to a thin solution of celloidin, in equal parts of absolute alcohol and ether; the ether should be the greater of the two if *not* measured, leaving the solution for two or three days until the mass has penetrated to all parts. Embed as usual, and when the eye is covered place the box on a glass plate, and cover with a bell-jar. The alcohol and ether diffuse into the air beneath the bell-jar, and the celloidin slowly consolidates. If a bell-jar is not used, a crust usually forms on the surface of the celloidin, and further evaporation is hindered.

The jar should be lifted from time to time, to permit of the partial removal of the gaseous alcohol and ether. The time the mass is required to remain under the jar depends much on the temperature of the room, and varies from one to six days. On account of size it is easier to cut the eye into pieces about quarter inch thick, and afterwards cut in the microtome. If the division is done before embedding, the lens will be displaced. When eyes are exceedingly large, and embedding is thus made difficult, re-embed one of these slices and so obtain a requisite degree of hardness.

Sections may be cut in three ways :—

(α) By freezing microtome.

(β) By any slide microtome, as Jung's.

(γ) By a microtome arranged that sections may be cut under spirit.

(α) Place mass in water for from six to twenty-four hours, until *nearly* all the spirit has been removed. Place in gum for a couple of hours or more, then freeze, cut and float off the knife in hot distilled water in a capsule. If all the spirit has been removed from the mass, the celloidin, when frozen, often becomes intensely hard and difficult to cut. This is readily obviated by placing the knife in warm water before cutting the sections.

(β or γ) Fix the mass firmly to a cork-covered plate. This is always difficult to do unless there is one flat surface to the celloidin. The most rapid method of fixing is to moisten the cork and the flat surface of celloidin with ether, and to firmly press the moistened surfaces against one another for five to ten minutes; the ether has then evaporated, and the celloidin adheres firmly to the cork. Another way is to smear some thick solution of celloidin over both surfaces, to press them together for fifteen to thirty minutes, then to place them in alcohol for twenty-four hours. There are also other methods for securing the mass, with gelatine or with paraffin, but the two described are rather more simple. The sections should always be manipulated between two pieces of tissue paper, since any rough usage causes displacement. The freezing method is used for all sections, but to some workers, in cases of LARGE sections, cutting under spirit is preferred. The section must be thoroughly dehydrated by long

immersion in alcohol, and may be cleared in one of three oils, viz. :—oil of bergamot, cedar oil, or turpentine. The first is most rapid and efficient ; at times, however, we meet with samples of bergamot in which the celloidin cannot be dissolved. Cedar oil is slow in action ; and turpentine often causes a disagreeable shrinkage. Mount in balsam.

Infiltration with Paraffin.—Is useful for preparations of embryo eyes, young animals, and of sections of eyes in those cases where examination of the lens is not required. Its chief merit is simplicity.

The Turpentine Process.—Harden the eyes ; open and stain as *before*, transfer from alcohol to oil of cloves, in which leave until cleared. Soak in pure turpentine for several hours, and finally place from eight to twelve hours in paraffin, melted at a temperature not OVER 50° C., 122° F. The paraffin displaces the turpentine, and permeates crevices of the tissue. Embed the infiltrated eye in the paraffin; sections may be cut and sealed to the slide. The most serviceable cement to use is a mixture of clove oil and collodion. It is practically impossible to stain sections after they have been cut and sealed to the slide. [By this method the lens crumbles to pieces.]

After Staining.—The eye is put in a mixture of alcohol and ether, equal parts, for twenty-four hours, and then submersed in pure chloroform for two days. It is finally placed in melted paraffin for twelve to forty-eight hours, and is treated subsequently as in the former case. By the use of chloroform the treatment with turpentine and clove oil is avoided. The eye *must* be stained in bulk.

Retina.—Müller's fluid. Open a fresh eye as above, place in fluid for two or three weeks, change as often as its altered appearance affords an indication of necessity ; transfer, after washing, to strong commercial alcohol. It takes about two weeks to completely harden. Sections thus prepared show the structure of the inner layers of the retina, and the course taken by the blood-vessels (in retinas which contain them), but the rod and cone layer and the outer nuclear layer are not so good.

Bichloride of Mercury.—A freshly-opened eye is placed in a saturated watery solution for three to six days, and finally hardened in alcohol as before. Some were placed in alcohol containing 2 per cent. of carbolic acid instead of simple alcohol. The salt "fixed" in a manner much superior to Müller, but allowed shrinkage in the rod-layer. The fixing solution must get access to the retina rapidly, and is accomplished by making an incision one-fourth the length of the circumference of the eye, and place at once in a fixing solution. At the end of thirty minutes or less the posterior part of the eye was removed by enlarging the original incisors with sharp scissors. By this means the fixing agent obtained access to the retina rapidly, and the detachment of the retina was prevented.

Picric Acid.—A fresh and opened eye is placed in a saturated watery solution of picric acid for three days, and the hardening was then completed in alcohol and carbolic acid. It is not a good agent except for showing the structure of the nervous layers. It is also possible to trace the Müllerian fibres, at all events as far as the reticular layer, since the previous immersion of the retina in picric acid seems to intensify the eosinophilous property which these fibres exhibit.

Carbolic Acid.—Place a fresh-opened eye in a 2 per cent. aqueous solution of the acid for a week; then harden in alcohol as usual. The acid itself does not harden. Fair specimens of all parts of the retina may be obtained thus.

Zinc Chloride.—Place the eye in 1 per cent. watery solution for a week and remove them to an alcoholic solution of carbolic acid. The action is similar to picric acid as regards the Müllerian fibres, but destroys the outer retinal layers.

Permanganate of Potash.—Place the eye in 2 per cent. solution for seven days. The alcoholic carbolic acid is not very satisfactory.

Chromic Acid.—Place the fresh-opened eye in one-sixth per cent. watery solution and leave for twenty-four to forty-eight hours. Finish hardening by alcohol and carbolic-acid solution. If left longer than forty-eight hours, staining is difficult to accomplish. It is very good for all parts except the rod-layer.

Chloral Hydrate.—Put the fresh-opened eye in 10 per cent. solution for from two to seven days, complete in alcohol and carbolic acid. It is uncertain, but still occasionally gave first-class results. It preserves the rod-layer, and it is possible sections may be got with the rods and cones *in sitû.*

Gold Chloride, in various strengths, given above. Osmic and chromic acid for from two to five days; then in a neutral, slightly-alkaline solution of the gold salt for thirty minutes. Transfer to a solution of weak formic acid at a temperature of 30° C., 86° F. in the dark; after twenty-four hours the reduction is complete.

Osmic Acid is about the most reliable re-agent. (*a*) Place the fresh-opened eye for twenty-four to forty-eight hours (not longer) in a watery solution of osmic acid, 10 per cent., and chromic acid one quarter per cent. Then place in a mixture of alcohol and carbolic acid for fourteen days or more. The retina is very hard, but not brittle. The sections show the structure of all parts of the retina, the rods being sharply defined and remaining *in sitû. N.B.*—It must be kept in solution NO LONGER than forty-eight hours, or it becomes brittle.

(*b*) Place the fresh-opened eye in 0·75 to 1 per cent. solution of osmic acid for from thirty minutes to twelve hours; then treat with either (*a*) alcohol, glycerine, and water; (*b*) alcohol; or (*c*) alcohol and carbolic acid.

(*c*) To obtain rapid penetration of the retina by the fixing re-agent, solutions of osmic acid and chromic acid in alcohol were employed:—(1) Osmic acid, one-tenth per cent.; chromic acid, one-fourth per cent.; commercial alcohol and water, equal parts. (2) Osmic acid, one-fifth per cent.; chromic acid, one-sixth per cent.; commercial alcohol and water, equal parts. Good sections were got with these except of the rod-layer.

(*d*) Place the fresh-opened eye in a solution of osmic acid, one-fifth per cent., and chromic acid, one-sixth per cent. (watery solution) for twenty-four to thirty-six hours. Then transfer to alcohol and carbolic-acid solution and treat as before. Excellent results.

Staining.—Retinal sections may be stained after being in celloidin, but if embedded by the paraffin or cacao-butter method,

the retina must be stained in bulk before it is embedded (at least the nuclear stain). The best stains are logwood and carmine; aniline is not so good. Kleinenberg's logwood and the alcoholic borax carmine have been given. If thick sections are required (as in search of blood-vessels) carmine is preferable, as it is more transparent; whilst in thin sections Gibbes' or Kleinenberg's logwood is the best. Leave the retinas in carmine about two days and in logwood from twelve to twenty-four hours. The exact time differs according to which hardening agent is used. To show the Müllerian fibres or blood-vessels, the sections of retina which have been stained in bulk with a nuclear stain should be stained (best on the slide) with either fuchsin or an alcoholic solution of eosin, preferably the latter.

Mode of Preparing and Mounting Sections.—

1.—Infiltration and embedding in celloidin and freezing.
2.— „ „ „ „ celloidin and cutting under spirit.
3.— „ „ „ „ paraffin.
4.— „ „ „ „ cacao butter.

1 and 2.—It is difficult to obtain thin sections by the second method, but fair ones are got by the first. The whole sclerotic, choroid, and retina should be embedded together, and when the celloidin is firm the retina and part of the choroid should be separated with a sharp scalpel. Earlier attempts only result in damage to the rod-layer.

Staining.—(*a*) To the water in which the sections have been placed on removal from the microtome add a little eosin. In a few minutes they will be sufficiently stained. (*b*) They may be placed at once on the slide with a section-lifter and stained there. Gently wash in either case after staining, and with *care* nearly dry with filter or blotting-paper. It must then be covered with a few drops of alcohol. On removing this re-agent with blotting-paper (*care* must be used not to get any fibres on the sections), clear in clove-oil or bergamot and mount in balsam.

3.—By paraffin method serial sections may be prepared.

4.—Infiltration and embedding in cacao butter. Stain a part of the eye with a nuclear stain, place it afterwards first in alcohol,

then in clove oil, then in cacao butter, melted at a temperature of 35°C., 95°F., for four to six, or even twelve hours. At the end of this time it should be embedded in cacao butter as usual. When hard, detach with a sharp scalpel the sclerotic and part of the choroid, and leave the retina and other part of the choroid to be cut in sections, whilst the rod layer has never been tampered with. Fix the retina by pouring over it a little more melted cacao butter to replace the mass cut away. Very thin sections can be made, and had better then be put on the slide and diffusely stained and mounted as follows:—A few drops of an alcoholic solution of eosin are poured over the mass and at once soaked in it; in a few minutes the mass is partially dried with blotting-paper. Heat the slide to a temperature of 35° C., 95° F. Remove the melted cacao butter as far as possible with blotting paper, and add a drop or two of clove oil to remove the remainder. When sections are cleared drop on the balsam. It is very important to remove as much of the cacao butter as possible before adding the oil, because the oil often acts very violently, and destroys the section. In fact, the great value of osmic acid and chromic acid as hardening agents is the great hardness they give the retina, the sections from which are not damaged by clove oil. The *best* sections may be got by this last method, used as an aqueous solution and stained in bulk by Kleinenberg's or Gibbes' logwood, and infiltrated and embedded in cacao butter.

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Two Important Biological Experiments.

BY MRS. ALICE BODINGTON.

TWO series of successful experiments have been recorded within the last six months in the *British Medical Journal*, an account of which I venture to think will prove interesting to the readers of this Journal. One bears directly on the question of the action of the environment on protoplasm, an action which appears likely to be reckoned as the governing law in evolution, taking the supreme place which the law of gravitation holds in physics.

The series of experiments to which I wish first to call attention have been carried out by Dr. Haycraft (Professor of Physiology at the University of Edinburgh) and Dr. Freund, each working independently.

The object of the experiments was to ascertain, if possible, the real cause of the rapid coagulation of the blood when drawn from the body. Some mysterious energy, called "vital force," was supposed, in the absence of any better hypothesis, to keep the blood fluid in living veins. This explanation was felt, however, to be as little truly explanatory in its nature as was the celebrated definition of an archdeacon—as a person performing "archidiaconal functions," and numberless efforts have been made to discover the true solution of the problem.

Under the ordinary conditions of healthy life the leucocytes or white corpuscles of the blood float quietly in the general blood-stream, living the life of parasites, to which air and food are brought by the medium in which they are bathed. The behaviour of these leucocytes, when any injury has happened to the tissues, or foreign organisms threaten the body, is in itself a study of absorbing interest, but one we cannot stop to consider now.* When blood is drawn from a vein, what is known as coagulation almost immediately sets in. The experiments of Dr. Haycraft

* A brief account of the action of leucocytes in conditions of disease, etc., will be found in the *Journal of Microscopy and Natural Science*, Vol. I., New Series, p. 17, under the title of "Micro-organisms as Parasites."

and Dr. Freund show that the changes in the blood, which take place during coagulation, are primarily changes of life, not death, and that coagulation may be indefinitely retarded if the leucocytes are prevented from coming into contact with any solid body, and are kept in a soft fluid medium, such as oil.

It will be interesting to give a detailed account of one experiment. A finger, previously well smeared with oil, and rendered turgid by a bandage, is plunged into a tube containing oil, and then pricked below the surface with a needle. The blood so obtained comes in contact only with the tissues of the finger in the puncture, neither the surface of the skin, nor the air, nor any particle of dust being permitted to contaminate it. The drops of blood will begin to descend in the oil, taking from ten to fifteen minutes to fall a foot. When the largest drop (which must on no account be allowed to touch the glass, or the experiment will fail) has nearly reached the bottom, the tube must be inverted, and the drops will again begin to fall, and this process may repeatedly be gone through. A drop may now be taken on a well-oiled spoon, and placed on a clean glass slide. It will be found on drawing a needle through the drop that it is perfectly fluid, there being an entire absence of any coagulation, even in the form of the minutest trace of fibrine threads.

The finger was then withdrawn from the oil, and carefully wiped, and a drop of blood, from the same puncture from which blood was drawn in the first experiment, was placed on a carefully-cleaned and dust-free glass slide. This slide was covered, and the cover ringed with oil to keep the blood from further contact with dust and air. It will be seen, however, how potent were the effects of contact with the dust of the air, and with a hard substance like a glass slide. The blood was immediately examined, commencing at 2.55 p.m., and amœboid movements could be distinctly seen in the white blood-corpuscles, which became gradually more active till, in three minutes, 2.58 p.m., fibrine threads were observed to be forming. At 3.3 p.m. the white corpuscles were still actively amœboid, though the field of the microscope was thickly covered with delicate fibrine threads. In some cases the amœboid movements continued for some hours, though in the blood of the experimenters coagulation occurred never

later than from five to ten minutes after the blood had been shed.

Dr. Freund's experiments showed that if the interior of a glass vessel were smeared with vaseline, and blood received into it through a greased cannula in direct communication with the artery of an animal, he could, by covering the blood so obtained, with a layer of liquid paraffin, keep it from coagulating for several hours. Prof. Haycraft also succeeded in keeping the blood fluid by pouring into a venous capsule containing some blood a mixture of vaseline and paraffin, and shaking this mixture from time to time with the blood. The blood-globules were thus isolated by the paraffin from contact with the wall of the blood-vessel, and under these circumstances remained fluid for some hours.

The life of leucocytes under the same conditions could not be prolonged indefinitely, as these amœba-like organisms are deprived of their natural supply both of oxygen and nourishment. What chemical changes in the corpuscles (or metabolism) lead to the production of fibrine we do not yet know, any more than we know how any of the organic ferments of various cells of the body are produced.

The earliest tribal history of the white blood-corpuscles, which play so wonderful a part in the life history of animals, may be guessed at from the individual history of certain flagellate organisms, in which some of the amœba-like cells set up currents of water with their cilia, and others simply ingest the food directed towards them by the ciliated cells. These feeding cells, which after a time immigrate into the interior of the flagellate colony, appear to be the prototypes of the white blood-corpuscles of the higher animals. In a later stage of the tribal history of leucocytes, they form the permanent internal layer (endoderm), or feeding cells, in animals as low in the state of life as hydra, and of all animals above the protozoa, in their gastrula stage. A profoundly interesting account, by Prof. Metschnikoff, of this theory will be found in the *American Naturalist*, for May, 1887, and the illustrations demonstrate the gradual advance from the flagellate colony of *Protospongia* to the *Gastrula* type.

The second series of experiments deals with a very different class of phenomena to that of the first—namely, the part taken by

electricity in nervous and muscular changes. "Nerve force," like "vital force," is a word which simply expresses our ignorance, but if the tenor of all experiments of late years points in the direction of "nerve force" being simply a form of electricity, we are dealing with something real, the laws of which can be understood. I will give the account of Dr. Waller's experiments,* chiefly in his own words.

He says:—"Our new bit of knowledge is about the human heart, not in a metaphysical or figurative sense, not its motives, but only its action. . . . . Put into a single sentence, I am going to describe how the heart of man can be said to act as an electrical organ, and what we learn from such an action.

"It is a well-known fact that every beat of the heart is accompanied by an electrical disturbance. The nature of this disturbance has been studied and understood in cold-blooded animals, and in the laboratory of St. Mary's Hospital an investigation has been carried out to learn whether warm-blooded animals show similar electrical disturbances. These latter experiments seem to indicate that, whilst the electrical disturbances appear to be similar in the two classes of animals, they are not identically so, and that the contraction, which at each beat of the cold-blooded heart runs down from the base to the apex, runs in the opposite direction in the warm-blooded heart."

"Led on from thought to thought," continues Dr. Waller, "it occurred to me that it should be possible to get evidence of electrical action on man by connecting, not the heart itself, which is obviously impossible, but parts of the surface of the body near the heart with a suitable instrument. Having verified this supposition, the next step was to see whether the same evidence could be obtained by connecting the instrument with parts of the body at a distance from the heart, as the hands or feet. The answer was satisfactory. Finally, I tried whether two people holding hands and connected with the instrument gave evidence of electrical shocks through each other, and I found they did."

Dr. Waller then proceeded to explain in detail the second step in these experiments, namely, an analysis of the results which are

* *British Medical Journal*, Oct. 6th, 1888. "Introductory Address on the Electro-motive Properties of the Human Heart," by A. D. Waller, M.D.

obtained when a single individual, whether man, horse, or dog, is connected with the electrical indicator.

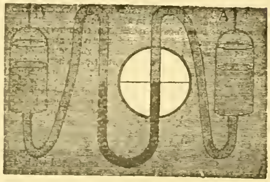


Fig. 1.

The principles of an electrical indicator may be understood by reference to the diagrams, in which the effects of water-pressure are compared with those of electrical pressure or POTENTIAL. A and B, Fig. 1, are two bottles of water, each connected by flexible pipes with a bent tube half full of mercury. If the two bottles are at the same level, the mercury in the bent tube remains at zero, and it is evident that this is still the case if both bottles be raised together or lowered together. But if the bottles be moved unequally, either up or down, the level of the mercury will alter. If A is lower than B, the mercury in this limb of the tube will move upwards, whereas if B is lower than A, it will move downwards. And if we imagine everything hidden from us by a screen, except a portion of the tube, whilst the two bottles are being moved by unseen hands, it is obvious we shall be able to tell by the movements of the index whether A is below B, or B below A.

Fig. 2.

Let our instrument now be applied to the heart. This, which

seems rather a bold proposition, is really a very simple and easy matter. We need simply dip the two hands into two basins of water, which are in connection with the indicator, when we shall see that the mercury beats up and down with the pulse. *These movements of the mercury are due to the electrical changes which occur with every beat of the heart.* Or, we may dip a hand and a foot each into a basin of water with a similar result, *only it must be the right hand; the left will not do.* This difference, apparently so curious and puzzling at first sight, which seemed unsymmetrical and irrational, is in reality most reasonable, and proved to be the master key which threw open the meaning of every subsequent experiment. The difference depends upon the unsymmetrical position of the human heart, which is tilted somewhat to the left side.

To return to the physical A B C of the subject. The points are respectively applied to the apex and base of the heart, and if, with the contraction of the organ, these two portions undergo any electrical change, the change will spread over the whole body in accordance with known laws. The form of the change is represented by the oval lines in the diagram (No. 3). If the electrical

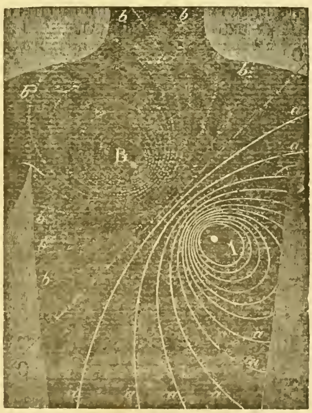


Fig. 3.

level falls at A, it falls over the red area (represented by continued lines), which, as we see, includes the left hand and foot and the right foot. If the electrical level falls at B, it falls over the blue

area (represented by dotted lines), which includes the right arm and the head.

Now, it is obvious that the two ends of the indicator must be connected with A and with B before it will indicate any difference between A and B. If both ends are connected with A, or both ends with B, nothing will be seen. This is precisely what happens when the left hand and a foot are connected with the instrument, which begins to pulsate as soon as the right is substituted for the left hand. If, again, the mouth and right hand are connected with the instrument, its index does not move, but it does as soon as the left hand is put in the place of the right one.

In the case of four-footed animals—dogs, cats, etc.—the heart is more centrally placed than in man—that is, it has not a decided inclination to the left side. In these animals, therefore, the two fore-paws and two hind-paws are opposed to each other, as will be seen in the diagram (Fig. 4). [Perhaps it will be better to

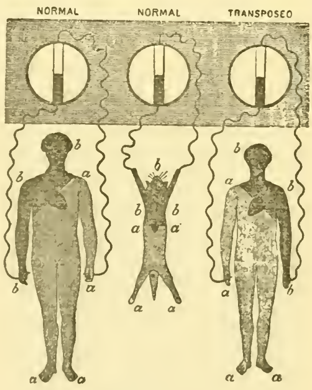


Fig. 4.

explain that the animal is NOT strung up in spread-eagle fashion to be experimented on, but stands in a natural position with the feet in bowls of water.] We know that no movement can take place in a muscle without a corresponding discharge of electricity ; in fact, that our whole apparatus of muscles and nerves constitutes an elaborate electrical machine.

Dr. Waller also proves by experiment that the electric shock passes through persons holding each other's hands, when the hands

are connected with the instrument. Have we not here a clue to the extraordinarily contagious character of the excitement arising amongst persons whose emotions have, in any way, been wrought upon, especially those in whom the highest brain-centres have not been well developed? The "Dancing Manias" of the middle ages form a case in point. The contagion (if I may be allowed the expression) spread from town to town, just as the advance of a disease like cholera may be noted step by step. The first authentic records of the dancing mania occurred in 1374, and in that year large assemblages of men and women appeared in Aix-la-Chapelle, and, *taking hold of each other's hands*, seemed to have lost all control over their senses. They continued dancing for hours together in wild delirium, until they fell to the ground in a state of exhaustion.* Their sufferings were relieved, as in the case of the convulsionnaires, at St. Médard, many centuries after, by sound beatings and tramplings upon the most sensitive parts of the body. When the disease was further advanced, the attacks commenced with epileptic convulsions.

In a few months this extraordinary malady spread from Aix-la-Chapelle to Cologne, and from thence into the Netherlands. In Metz, as many as eleven hundred, and in Cologne five hundred dancers filled the streets. Peasants left their ploughs, mechanics their workshops, housewives their domestic duties to join the wild revels, with such consequences, both to commercial prosperity and morality, as may readily be imagined. The disease waxed and waned, but did not completely die out till the 16th century. The exciting cause, so far as it can be traced, seems to have been the terror and despair felt by the inhabitants of Europe at the frightful ravages caused by the Black Death and the Plague.

Strange, contagious, nervous disorders have also been very frequent in convents, where a number of under-educated women are living together under conditions in which all healthy emotions are killed out, or placed under cruel restraints, and all unhealthy, hysterical emotions are fostered. In a well-known case, one nun in a convent having begun to mew like a cat, all the other nuns began to mew also, and nothing could put an end to this odd chorus, until a company of soldiers were placed before the doors

* "The Dancing Mania of the Middle Ages." F. F. C. Hecker, M.D.

of the convent, armed with rods, and with orders to soundly castigate the mewers.

A still more alarming nervous epidemic broke out in a German convent in the 15th century. One nun bit some of her companions, and in a short time the biting passed round with interest—all the nuns began to bite one another. The news of this infatuation among the nuns spreading, the epidemic passed from convent to convent through a great part of Germany, and even extended as far as Rome. (Zimmermann on "Solitude.")

In Italy, the dancing mania occurred much later than in Germany, and took the form of "Tarantism," that is, the disease was supposed to be caused by the bite of a certain spider—Tarantula—and a cure would only be effected by violent dancing. But Tarantism was just as infectious and as independent of any bodily spider as other nervous epidemics. It was at its height when Italy lay in her lowest state of degradation, in the 16th century, and then, in spite of spiders, very gradually died away.

Dr. Hecker pursues the history of nervous epidemics as they have appeared in Protestant countries, chiefly in connection with advanced Calvinism. He traces the disease as it breaks out in camp-meetings in the United States, and as it appeared in isolated districts of Scotland, always showing the same main symptoms; the seizure of one or two amongst the audience, and the rapid infection of the rest; the utter loss of self-control, the shrieks, the cries, the groans, and finally the prevalence of all these symptoms amongst the ignorant or the half-educated, leaving the cultivated classes untouched.

It is sometimes assumed that nervous and "hysterical" diseases are on the increase in our days. It is true that the meagre survivals of these diseases have been studied as they never have been before, but they are studied as anthropologists examine the habits of native Australians, or the Ainos of Japan, before these low races have passed away. Nervous diseases, which raged furiously for centuries amongst thousands of people, and over widely-stretching countries; which caused innumerable deaths and untold sufferings, and which convulsed society in Germany to its foundations, are now confined to sporadic cases of hystero-epilepsy in our asylums. From this point of view, the wildest

freaks of the most excitable of modern religious sects appear as mild, quiet, and decorous services, and show how even the half-educated have advanced in self-control.

Probably, the communicability of electricity from one person to another may have something to do with the curious phenomena of what is known as "thought-reading." I must premise that I exclude all experiments in "thought-reading" where a paid or professional expert of any kind is employed. Our senses are so entirely at the mercy of any skilled juggler, that I should not be surprised if an expert of this kind could tell me what my grandmother thought when my grandfather proposed to her. But I have seen cases in my own family which appear to me unaccountable, except on the supposition that something physical can be conveyed from one person to another, which influences the second person, and which may be conceived to be of the nature of electric force. I form a mental image of the thing I wish the person experimented upon to do; I concentrate my attention as strongly as I possibly can upon this mental image, and, at the same time, I "will" strongly that the thing should be done. All this concentration of thought and will involves a kind of exertion very difficult and exhausting to keep up long.

In the last experiment I tried, I wished my little girl, aged 12, to take a bunch of flowers out of a vase (standing with a number of other ornaments) on the sideboard, and to put the bunch of flowers in a certain basket on the table. All this was done, very slowly, but quite accurately, nor had the child any idea whilst she was accomplishing these acts, of *what* it was she was required to do. I often fail; often succeed only partially in these simple experiments; and the failures or partial successes seem to correspond with the idiosyncrasies of the children. Where no professional is concerned, the communicability of electric nervous force may account for many queer eccentricities on the part of hats, chairs, and tables. And it may also account for the strange influence which some persons exert over their fellow-creatures. They may be neither strong, nor wise, nor clever, their tempers are probably equable, and they do not rule by fear; yet they *do* rule, or in ordinary phrase, "get their own way in everything." My readers will probably be reminded of Leonora Galigai, the

unscrupulous niece of Cardinal Mazarin, who, when asked what witchcraft she had exercised in gaining her mastery over the mind of Marie de Medici, answered, "My only witchcraft has been the influence of a strong mind over a weak one."

Cements, Varnishes, and Cells.*

By H. N. Lyon, M.D.

EVERY one who continues in a given line of work for a number of years gradually confines himself to the use of a few agents. It is especially so in microscopy, and in these few remarks on cements, varnishes, and cells, I shall mention only those that I have adopted, after having tried many and met with many failures.

I have selected this subject because, to me, it is of great importance, and while I may not add anything to the existing knowledge of the subject, my testimony may be of value in helping to settle that vexed question as to what makes the best cement, varnish, or cell.

For some eight years I have been experimenting in this line, and the experiment which finally settled the question, in my mind, was made in an unexpected way. Some years ago I packed my collection, numbering at that time many hundred mounts, in a trunk, and took it with me on my wanderings. Altogether the collection travelled between 15,000 and 20,000 miles, mostly by rail. It fared badly, but I consider the loss as slight in comparison with what it taught me regarding the powers of endurance of the various cements, media, etc. For obvious reasons it is impossible to give exact figures and I can only give the general result. There were only a few slides or covers broken, but the number of mounts ruined by the covers coming off or separating so that air entered was very large. The cements which stood this test the best were gold-size and the solid marine glue. Balsam

* From *The Microscope.* A paper read before the State Microscopical Society, January 11th, 1889.

mounts, which were strengthened by a ring of varnish, were but little affected, while those not so protected suffered greatly. None of the wax cells made, as described later on, lost their covers or separated from the slide, while a large number of those made by cementing rings of wax to the slide were spoiled. Shellac, not backed up by a tougher cement, gave out in almost every instance.

Gold size has been a favourite cement with me for a long time. Some eight years ago I procured a number of bottles from Messrs. Queen & Co., and some that is still left seems stronger than when first bought. Gold size is simply linseed oil rendered very "*drying*." There are, however, a number of different formulæ for its preparation, and when you find a sample that is of more than ordinary worth it is well to lay in a supply. The same holds true of all such material as is not liable to deteriorate with age. Gold size hardens by oxydation, and very slowly at that; so a sufficient length of time must be allowed for each coat to become hard. If it were not for the slowness with which it hardens it would make an admirable cell. As it must be applied in very thin layers it takes too long to make cells of any great depth, and unless they are carefully made they will eventually break down. I use gold size for dry mounts, to attach metal cells, to "pack up" a more brittle cement, and, in fact, in all cases where it is possible to do so.

Another cement, which works well with me, is Shellac. It must be the genuine article, and not the resin compound that is frequently sold for it. Shellac I prepare as follows:—Put a few scales of orange lac in a wide-mouthed bottle and cover with 95 per cent. alcohol. The bottle is placed in a water-bath, and a gentle heat applied until the shellac is dissolved, when it is filtered through muslin or absorbent cotton, previously moistened with alcohol. If too thick, add more alcohol and continue the heating for a short time. The shellac must be thin, as if thick it does not adhere as well. It will in course of time become thick from the evaporation of a portion of the alcohol, when it should be prepared afresh. The rule that cements and varnishes are deteriorated by being thinned after they have become thick by evaporation or oxidation has few, if any, exceptions.

If desired, the bleached lac may be used when the light orange tint of the other is an objection. This makes a colourless solution, but its adhesive powers are much less than those of the orange lac. It is prepared as follows :—From the centre of a stick of bleached lac select a few small pieces and dissolve them in absolute alcohol, by the aid of a gentle heat. The central portion is chosen as it has been less exposed to atmospheric influences, and the fresher the specimen the stronger will be the resulting solution. If the bleached lac can be procured fresh enough, it makes a very fair cement, but if old it may be insoluble.

Bell's cement and liquid marine glue are shellac cements, and seem to be no better than the simple alcoholic solution.

Shellac works well on glycerine mounts, as a varnish for the inside of wax cells, to attach the cover-glass, and especially is it valuable as the first coat, when it is desired to "ring" a balsam mount. Being of the same colour as the balsam, if any should run in, it mixes readily with it and is not noticeable. As it dries so rapidly when thin this seldom occurs. I always finish balsam mounts with a ring of varnish, as they look neater and last much longer. By the use of shellac no time need be lost in allowing the balsam to harden, but the mount can at once be put on the turn-table and a ring of shellac run around the edge of the cover. In ten minutes this will be hard enough to receive a coating of white zinc, Brunswick black, or some other quick-drying varnish, and in twenty-four hours the mount can be safely entrusted to the mails.

Shellac is too brittle to be used alone as a cement, and must always be backed up with some more tenacious varnish.

White zinc is my favourite in glycerine mounts, but it is far from being perfect. Glycerine is almost a universal solvent, and after a time the white zinc will crumble. This can be greatly retarded by giving the mount a fresh coating every two years. Unless well made this cement is worthless. It is the oxide of zinc suspended in a solution of dammar in benzole. The bottle must frequently be forcibly shaken to keep the mixture uniform. It should be used as thick as possible, or on drying there will not be enough of the damar to prevent crumbling. As the benzole is very volatile the solution must be used rapidly. The secret of

its use is that it must be used quickly, the bottle must not be left open, and it must not be too thin. Aside from its use in glycerine mounts I only use white zinc as a finish. Some of you probably remember the controversy between Mr. Hitchcock and Dr. Stowell regarding the merits of white zinc. As I have a number of mounts sent me by Dr. Stowell which have given out, I must add my testimony to that of Mr. Hitchcock. However, until something is found which will permanently confine glycerine, I shall continue to use the white zinc, as I think it is the best cement we now have for that purpose. If care is taken to remove all traces of glycerine from around the edge of the cover before the cement is applied, and each coat allowed to become thoroughly dry before another is applied, you can expect a good mount.

Other fluids than glycerine I seldom use. I find, however, that one or the other of these three cements will confine almost any fluid liable to be used.

First on my list of varnishes is white zinc. This I use for its colour alone, as it is apt to become brittle with age. My usual finish is a broad ring of white zinc, with one or two narrow stripes of Brunswick black.

Brunswick black makes a very satisfactory finish, as it dries a glossy black, and does not chip. It makes a very pleasant contrast with the white.

Occasionally I employ a red varnish made by dissolving the best red sealing-wax in alcohol. This gives a bright red varnish that stands well. The best sealing-wax must be used, as the cheaper kinds are brittle.

Shellac I use to varnish the insides of cells, and to support old mounts that have begun to give way. Being colourless, it does not destroy the individuality of the mount. By adding an alcoholic solution of an anilin to a solution of orange lac, and evaporating until of the proper consistency, a very brilliant varnish may be made. If exposed to a strong light these varnishes are apt to fade.

For very shallow cells I employ gold size. If deep ones are desired, I prefer wax, paper, and glass or metal rings. In a few instances I have had good results from cells made of asphalt and baked before being used. It is essential that the genuine asphalt be used and not the coal-tar product.

Cement cells must be built up one coat at a time. If the second coat is added before the first is perfectly hard, the cell will eventually break down.

The best cell that I have found for dry mounts is made by punching a hole in a piece of blotting paper of the proper size and thickness. This is cemented to the slide with mucilage. A paper "front" must be used, for, if a varnish is used, it will defeat the object of the paper cell. If sweating should occur in one of these cells, which only happens in exceptional cases, it is only necessary to lay the slide on the warm table and apply a gentle heat. As soon as the blotter is dried out it will absorb all the moisture that may be in the cell.

For balsam mounts I use brass curtain rings, cemented to the slide with gold size, and well varnished on the inside with the same.

For dry mounts which are not liable to give off moisture, I employ wax cells. They are quickly made and are very strong. My method is as follows: A piece of single-thick sheet-wax, such as is employed in making artificial flowers, is put on the centre of a slide and held there by pressing the ball of the thumb against it. The heat of the hand is just sufficient to make it adhere. When the first piece is firmly attached, which can be told by the absence of air bubbles when viewed from below, a second piece can be added and secured in the same manner. In this way cells of any depth can be made. When the wax is of the required thickness the slide is placed on the turn-table and with a sharp scalpel a cell is " turned " out of the mass, as a turner fashions a bowl in his lathe. A damp cloth on the end of the finger or a small stick is used to clean the glass inside the cell. The wax must be well varnished, or the volatile portions will escape and collect in fine beads on the under surface of the cover. Wax cells made in this way seldom become loosened from the slide, even when roughly handled.

Glycerine mounts I put up in glass cells. As these should be attached to the slide with the solid marine glue, it is better to get them ready prepared. I secure the covers with shellac, as it is less liable to run in than white zinc. These mounts afterward receive a coat of white zinc as a safeguard.

You will notice from these remarks that I am an advocate of the wax cell and shellac varnish. The merits of the latter are now pretty generally known, and if once used it is not apt to be discarded. It must not be trusted to alone, as it will not stand sudden jars. The wax cell is still a disputed subject. I know they are liable to sweat, but I think I can safely hazard the statement that not one dry mount in fifty, not put up in an absorbent cell, will show an unclouded cover after a few years. Objects of the mineral kingdom alone do not give off vapours.

Again, we must not lay the defects of the cover-glass itself to this cause. If you examine carefully a number of cover-glasses, taken from different packages, you will find quite a proportion show an appearance resembling minute beads of moisture on the surface. This is due to a roughness of the glass, which prevents the light from passing through properly. If such glass is used on balsam mounts the defect is not noticeable, but if used for dry mounts an amount of sweating that would ordinarily be of little moment will so intensify the effect that the mount is declared ruined and the cell gets the blame. My experience with wax cells has been very great, and when carefully prepared I do not think they are any more liable to sweat than any form of cell that is hermetically sealed. If it were possible, I would put up everything in a solid medium, such as balsam or Farrant's solution. Such preparations will remain long after those dry or in fluid have been thrown away.

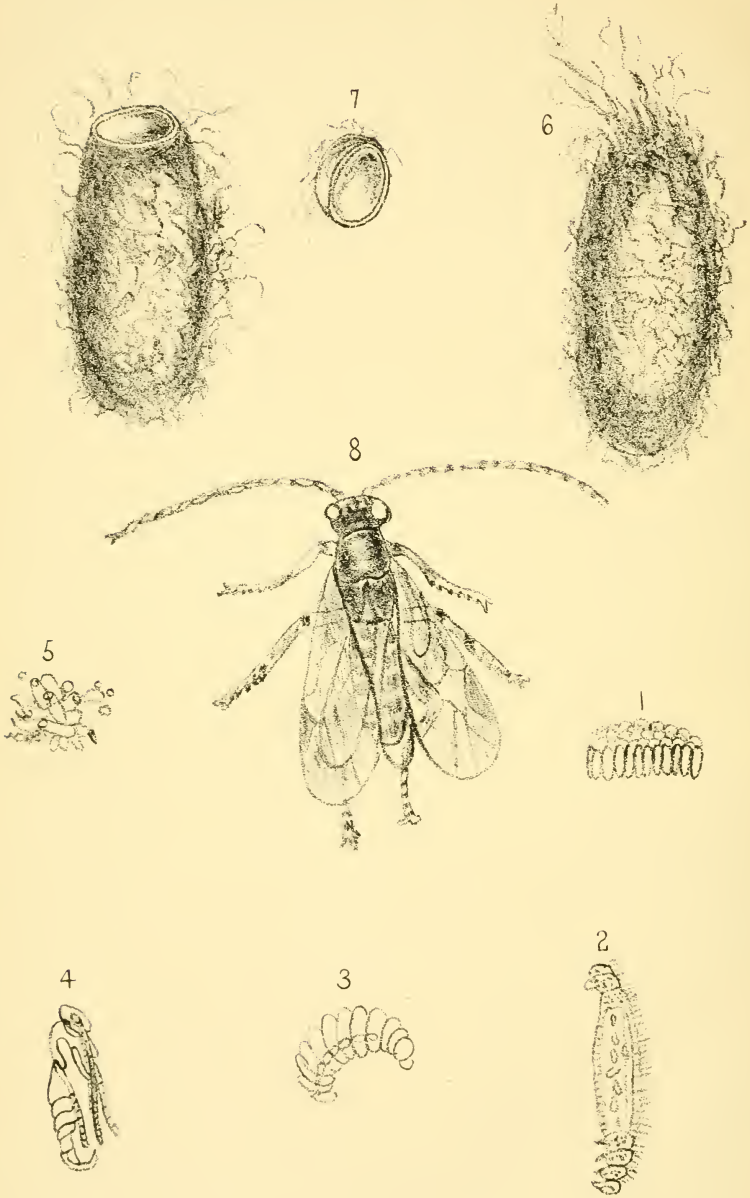
272 Thirty-first Street, Chicago.

Hardening Brain.—Take a 6 per cent. solution of HNO_3; put the brain or spinal cord in, and leave it for from three to four weeks. I have found it a most excellent method. The brain looks like a papier-maché specimen, and I have one which I have kept over four years without any change in its appearance.—*V. A. Latham, B.Sc., F.R.M.S., Univ. of Mich.*

Half-an-Hour at the Microscope,
With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

True Avanturine.—It would be curious to trace the history of the "True Avanturine" slide, first labelled "Hypersthene," but which now turns out to be Serpentine, and how its first name was originally given to it. I have sometimes had doubts whether wrong names have not sometimes been purposely given, to prevent the real nature or source of specimens being ascertained. This, from a scientific point of view, cannot but be considered as exceedingly reprehensible. It is evident that from *some* cause great confusion has prevailed on the present subject. A clever and amusing writer in the *Quarterly Journal of Microscopical Science*, April part, 1861, p. 135, extols a good specimen of "Hypersthene" in high terms. In the July part of the same periodical, p. 219, in reply to a correspondent who, "with one of our first London opticians, could not make it that wonderful object you speak of," he rejoins, "Very probably not; for among the different specimens I have examined, I have not seen another equal to mine. . . When it is first-rate, and exhibited . . with inch objective and Lieberkühn . . . and at night by intense lamp light, without a 'modifier,' I think it stands quite at the head of what may be called the gorgeous class of objects, and I find it more frequently elicits that rapturous Oh ! ! ! (which sounds so delightfully at a microscopic soirée) than many other of that class, *e.g.*, peacock copper, ruby copper, needle antimony, iron ore from Elba, elytron of *Curculio regalis*, etc." Thinking that the manufactured is probably more brilliant than the natural mineral, one is led to surmise whether the choice specimens here described were not after all just "Artificial Avanturine." Our thanks are specially due to the contributor for correcting the nomenclature.

Microgaster glomeratus.—The illustrations of *Microgaster glomeratus* are interesting. In *Science Gossip* for 1865 (p. 71) is a curious account of "Cocoons found on squeezing a caterpillar." Presently these "Cocoons" have become larvæ, climbing the window-panes, and in the next sentence we are told of the "*Larvæ depositing small heaps of the cocoons, protecting them with a covering of yellow silk!*" The structure of the cocoons, closely felted inside, like silky flannel without, admirably fits them for protecting the little inmate through the inclement winter weather. The precision, too, with which the young creature, when about to make its exit, has sheared off with its jaws one end of its temporary shroud and coffin, is also well worthy of note. (See Pl. XXIII.)



Microgaster glomeratus.

EXPLANATION OF PLATE XXIII.

Fig. 1.—Mass of cocoons.
,, 2.—Larvæ inside of caterpillar.
,, 3.—Larvæ enlarged.
,, 4 —Pupa of an Ichneumon (after Westwood). (These 4 illustrations taken from "Introduction to the Modern Classification of Insects," Vol. II., p. 148, Fig. 76.)
,, 5.—Mass of cocoons deposited in the autumn of 1877. (Westwood's figure represents them as too regularly arranged. I find them heaped together in all sorts of positions, like a lot of tired children that have tumbled down together after play and fallen dead asleep, no matter how or on whom they fell.)
,, 6.—Cocoon in its entire state.
,, 7.—One from which the Ichneumon has recently made its exit; the end cut off remains like a lid to the "win" (cocoon).
,, 8.—*Microgaster glomeratus*, Imago.

Selected Notes from the Society's Note-Books.

Calcareous Nodule from Coal.—This was taken from a seam of coal worked about Oldham. These nodules are full of the remains of the vegetation which flourished so luxuriantly during the formation of our coal-seams. The section enclosed is cut transversely, and shows three or four forms of *Rachiopteris*, several of which have been described in a memoir of the Royal Society, read March 25th, 1874, by Prof. W. C. Williamson. These ferns will vie with any recent ones in the peculiar arrangement of the vascular bundles. J. BUTTERWORTH.

Fin of Flying-Fish.—*Exocœtus evolans* is a tropical species and not identical with that occasionally found in the Mediterranean (*E. volitans*). There are, however, I believe, many more species, though not many of them have been described. The membrane of the pectoral fin, or wing, is in some parts strongly marked with star-like spots, whilst in other parts the fin-marks entirely disappear. The fin-rays polarise tolerably well. The fish, when alarmed, leaps from the water and skims along, perhaps 100 or 200 yards, seldom rising more than a foot or two above the water, the wings vibrating rapidly all the time. Such, at least, is my impression, though some writers have asserted that they only act as a sort of parachute, and that the force of the jump alone propels the fish. This may be the case with some species, but I am certain that this species remains on the fin for a considerable

distance, and goes at a good pace, which seems quite incompatible with the effects of a mere leap. A salmon is undoubtedly a very active fish, but his leap, which will take him up a fall, would not carry him far along the surface, were he furnished with ever-so-well-made a "parachute." I have watched Flying-Fish for hours getting up by twos and threes before the bows of a ship in certain latitudes where they abound, and a pretty sight it is. The pectoral fins are extremely long in proportion to the body—about four-fifths of its whole length—and are moved by very strong muscles. Cuvier says that the flexors which move the fins do not act differently from those of other fishes, excepting that they move more freely. The fish from which this slide was taken flew on board a ship with which I am acquainted. R. A. HANKEY.

Foraminifera from March.—"Post-glacial sands, March, Cambridgeshire," a most interesting object, as exhibiting Foraminifera of species still existent, the shells being as perfect as those gathered to-day, although "as old as the hills." The slide contains at least twenty distinct species of Foraminifera. The species are, in some instances, difficult to determine, partly on account of the shells being loose in the cell, and being thereby rendered difficult to put in position, so as to see accurately the various points desirable to be examined in detail.

The Textularia look as if "rough-cast"—somewhat like the ARENACEOUS division of the Foraminifera, although strictly belonging to the HYALINE, or glassy—to which family the Lagena group belongs. The PORCELLANOUS division is represented by Cornuspira, Biloculina, Triloculina, and Quinquloculina. Thus, this slide contains representations of two of the three great divisions of the Foraminifera.

The *Porcellanous* division is "imperforate"—*i.e.*, the shell is not (usually) pierced all over with minute perforations, but only at the mouth or septum.

The *Hyaline* division has the shell perforated all over, more or less. In some species (*Operculina* and *Cycloclyphus*) these perforations are about one-ten-thousandth of an inch in diameter; while in Rotalia they are about one-three-thousandth of an inch. These perforations may be distinctly seen on some of the specimens in the slide.

There is no proper representative of the ARENACEOUS division. Almost everyone of these shells is described and figured in Williamson's Recent Foraminifera of Great Britain (Ray Society) and others, in the Philosophical Transactions for 1865, in a paper on the Foraminifera of the North Atlantic by Jones and Parker.

The slide also contains three or four species of Ostracoda and fragments of Echinus spines.

It is an interesting fact, that a deposit of Estuarine clay, above high-water mark, found on the shores of Larne Lough, in co. Antrim, Ireland, contains all the species in this slide, which are, as a rule, only small, though distinct. It is also interesting to find that the same species are now existing round our coast.

As these shells from the March sands are not at all fossilised, they may readily be obtained from the sand by the process of "floating" which I have described in the Journal, Vol. I., the sand being first *thoroughly* well dried. The sand, which sinks to the bottom of the vessel in which the "floating" is performed, should be examined for the larger Foraminifera, which, *I think*, have been lost by the process employed to obtain those in the slide under notice. The heıvy porcellanous Forams will not always float. They may, however, be obtained easily from the wet sand by the process recommended by Williamson—viz., draining off the water from the sand on a dish or plate, and shake the plate by tapping it gently; the larger Forams, if present, will rise to the surface and may be picked off. Another plan which I have found effectual is to pass the dry sand through a *very fine* gravy-strainer with *round* holes, which will stop the Foraminifera from passing.

This slide contains the following species :—

Hyaline group :—Polystomella crispa; P. striata punctata; Planorbulina mediterranensis; Nonionina depressula; Rotalia becearii; R. nitida; Polymorphina gibba; Globigarina bulloides (very large); Textularia variabilis; Bulimina pupoides; B. ovata; Lagena lævis; L. melo; L. sulcata; L. caudata; L. lucida; L. marginata; L. globosa.

Porcellanous group :—Cornuspira foliacea; Triloculina trigonula; T. oblonga; Quinque loculina sub-rotunda; Q. bicornis.

Making 22 species, with a possibility of some others.

C. ELCOCK.

Flying-Fish.—The name of the tribe (*Exocœtus*) has a curious derivation. It is from εκ (outside) and κοιτη (a bed), so called from the supposition, held in old times, that these fishes *slept on land*. It must be a beautiful sight on a clear day to see them sparkling in the air with silvery brightness, or rushing from the waters when pursued by their enemies, spreading out their large fins, their brilliant purple backs gleaming, and their sides blazing like molten metal under the dazzling light of a tropical sun. The greatest length of time that they remain in the air is 32 seconds, and their longest flight from 200 to 250 yards. They belong to the same family as the Pikes.

E. E. JARRETT.

The Late Dr. Royston-Pigott.

AT the moment of going to press, it is with great regret that we record the death of Dr. George West Royston-Pigott at Eastbourne on September the 14th. Dr. Royston-Pigott was a frequent contributor to this Journal, and one of his latest literary productions appears in the present number. He was the youngest son of the late Rev. S. Pigott, M.A., Rector of Dunstable, Beds., and was educated at Cambridge, where he took the degree of M.D., and then began to practice at Harrogate. His wife was a daughter of the late James Royston, of Halifax.

He was a Fellow of the Royal College of Physicians, and, in recognition of the value of his researches in Microscopy and Astronomy, was made a Fellow of the Royal Society. He closed an honourable and useful life, after having reached the allotted span of three-score years and ten.

Reviews.

THE ELEMENTS OF BOTANY. By E. S. Bastin, A.M., F.R.M.S. 8vo, pp. xiii.—283.

COLLEGE BOTANY. By E. S. Bastin, A.M., F.R.M.S. 8vo, pp. xv.—451. (Chicago: G. P. Engelhard and Co. 1889.)

The former of these two works deals with Organography, Vegetable Physiology, Nomenclature, Classification, Illustrations of Plant-Types, etc., with a Glossary of Botanical Terms. There are nearly 450 illustrations, chiefly from drawings by the author. The *College Botany* enlarges upon the subjects dealt with in the previous volume, and contains many additional illustrations, with a brief account of the succession of plants in geologic time. The author is well known as a botanist and microscopist, and the reception accorded to previous editions of these books testifies to the value attached to them by those who wish to gain a thorough insight into this delightful study. The chapters read as though written by an able teacher.

THE USES OF PLANTS: A Manual of Economic Botany. By G. S. Boulger, F.L.S., F.G.S. Crown 8vo, pp. viii.—224. (London: Roper and Drowley. 1889.) Price 6s.

The writer, who is Professor of Botany at the City of London College, reviews the position of Economic Botany fifty years ago, and then gives an account of the progress made in this special study during the last fifty years. Part I. supplies some useful information on Foods and Food-stuffs, the separate sections treating of starches, sugars, pulse, roots, etc.; Part II. considers the *Materia Medica*; then follow chapters on Gums, Resins, Dyes, etc. A systematic, synoptical index and general index complete the volume.

NAMES AND SYNONYMS OF BRITISH PLANTS. By Geoffrey Egerton-Warburton, M.A. Foolscap 8vo, pp. xxxvi.—160. (London: George Bell and Sons. 1889.)

This handy volume contains the nomenclature of the London Catalogue, English Botany, Babington's Manual, Bentham's Flora, and Hooker's Student's Flora, also an Appendix, giving other names and their synonyms, with a list of authorities for plant names. It is specially useful to students as a book of reference.

MARINE AQUARIA: Their Construction, Arrangement, and Management. By Reginald A. R. Bennett, B.A. pp. 135. (London: L. Upcott Gill. 1889.)

Full information is here given as to the best animals and seaweeds to be kept in a marine aquarium, also the best means of keeping the balance of animal and vegetable life in it. Visitors to the seaside or residents there will find much pleasure to be obtained by following up the healthy pursuit of collecting, preserving, and examining the life of marine creatures as here advised.

THE A B C OF ELECTRICITY. By William H. Meadowcroft. Post 8vo, pp. 108. (London and Manchester: John Heywood. 1889.) Price 2s.

The MS. of this work was submitted to Mr. Thos. A. Edison, the well-known electrician, and in his letter to the author he makes the following favourable remarks:—"The statements you have made are correct. Your treatment of the subject and arrangement of the matter have impressed me favourably." This of itself is a sufficient recommendation.

THE FLORA OF SWITZERLAND, for the use of Tourists and Field-Botanists. By A. Gremli. Translated from the fifth edition by Leonard W. Paitson. Post 8vo, pp. xxiv.—454. (London: David Nutt. 1889.) Price 7s. 6d.

This is an English edition of an important work recognized by botanists of eminence on the Continent. The book contains all the phanerogams and vascular cryptogams which grow spontaneously in Switzerland, and also has an appendix containing a list of the species found in adjacent countries. The many English botanists who visit Central Europe will find here a useful botanical guide in their excursions.

CHARACTERS AND EPISODES OF THE GREAT REBELLION, selected from the History and Autobiography of Edward, Earl of Clarendon, and edited with short notes by the Very Rev. G. D. Boyle, M.A., Dean to Salisbury. 8vo, pp. xv.—366. (Oxford and London: The Clarendon Press. 1889.)

The student of modern history will find in these selections very much

assistance toward the understanding of the lives of those who were foremost of their day, either in the leading of parties or in the formation of governments, and, as the editor quotes in his introduction from Lord Macaulay, "There are few things in English literature better worth a young man's study than the character of Clarendon." The notes appended to the work have been carefully arranged and condensed, so that, although only occupying a small portion of the volume, they considerably help to clear away any difficulty that might be felt by simply reading the unaided text. The type is distinct, and the whole appearance of the book savours of the good style of the Clarendon Press.

THE WORKS OF HUBERT HOWE BANCROFT. Vol. XIX., History of California (Vol. II.). (London: Trübner and Co. San Francisco: The History Company. 1886.) pp. i.—xvi. and 1—795.

The period embraced in this most interesting history extends from 1801 to 1830. The author's method of dealing with the wonderful number of facts brought together from so many different sources for giving the public correct views of the past of California, with its multitudinous teachings, is at once so lucid in statement and clear in argument, that the ordinary reader is captivated by it. The regular student of history, however, will find such stores of valuable historical information, and such excellent reasoning on the various questions involved in a country's social and political development, that he will lose much if he does not carefully read these works. We have had other volumes of the same series before us, and have given our word of praise with regard to the clear, readable type in which they are printed. This also possesses the good qualities of its predecessors.

THE HANSA TOWNS. By Helen Zimmern. Crown 8vo, pp. xvii.—389. (London: T. Fisher Unwin. 1889.) Price 5s.

This is another of the series, entitled "The Story of the Nations," from which the student of history has gathered much interesting matter, put together by writers of repute in their several departments. We have already noticed several of the series, and can recommend this as maintaining a worthy place among its accompanying volumes. There are many illustrations of noted places connected with the Hansa League.

THE ILLUSTRATED MEDICAL NEWS, Nos. 39—51. (London: *The Illustrated Medical News* Publishing Co., Limited.) Price 6d. each part.

These numbers, as usual, contain a large amount of information of peculiar interest to the profession to whom they are addressed. The coloured plates, of which one will be found in each number, are of the highest order of excellence, and as many of the illustrations interspersed with the text are from photographs there can be no doubt of their faithfulness. Nos. 47 and 48 contain special reports of the meetings of the British Medical Association at Leeds.

ON DISORDERED DIGESTION AND DYSPEPSIA. By Frank Woodbury, A.M., M.D. pp. viii.—82. Price 25 cents.

ON THE TREATMENT OF THE MORPHINE HABIT. Translated from German by E. P. Hurd, M.D. pp. xvi.—113. (Detroit: Geo. S. Davis. 1889.)

Two volumes of "The Physician's Leisure Hour Library," treating of their respective subjects in a very thorough way; the Authors being specialists in these departments of Medical Science.

THE CLINICAL USE OF PRISMS; and the Decentering of Lenses. By Ernest E Maddox, M.B. pp. 113. (Bristol: John Wright and Co. London: Hamilton, Adams, and Co. 1889.)

The object of this work is to communicate a series of aids to precision in the use of prisms, and so render service in a difficult by-way of ophthalmic practice. The simplest properties of prisms are first considered, and these are supplemented by a brief account of their chief clinical uses.

THE PHILOSOPHY OF SIGHT. By A. Fournet. pp. 196. (London: Swan Sonnenschein and Co. 1889.) Price 1s.

The Author starts with the question—"Is bad sight on the increase?" and enters fully into the consideration of the various diseases of the eye, and the most common operations and treatments for bad vision. There is much that is new, much that is original, in the Author's statements.

CREMATION AND URN-BURIAL; or, The Cemeteries of the Future. By W. Robinson. Post 8vo, pp. 201. (London: Cassell and Co. 1889.)

This book discusses the advantages of the form of burial known as Cremation, taking up the cause very earnestly. There are several illustrations, and the work is dedicated to Sir Henry Thompson and Sir Spencer Wells.

HEALTH TROUBLES OF CITY LIFE. By George Herschell, M.D. Post 8vo, pp. 71. (Bristol: John Wright and Co. London: Hamilton, Adams, and Co.)

In the preface the Author says, "These pages deal with the Health Troubles of City Life, which are the outcome of the age of competition in which we live." We have received much profit from the perusal of the work, and heartily recommend it to many who have to carry on their duties under the excessive strain of town-life.

DISEASES AND INJURIES OF THE EAR: their Prevention and Cure. By C. H. Burnett, A.M., M.D. Post 8vo, pp. 154. (Edinburgh and London: Young J. Rutland. 1889.)

The subject is presented to the reader in a form free from technical terms, so that it may be understood by anyone. Attention to the advice given will enable many to avoid ear-diseases, and also to avoid the evils of improper treatment for them.

DERMOIDS; or, Tumours containing Skin, Hair, Teeth, &c. By J. Bland Sutton, F.R.C.S. Post 8vo, pp. 131. (London: Bailliere, Tindall, and Cox. 1889.)

The facts and opinions contained in the book formed the substance of the Author's Hunterian Lectures, delivered at the Royal College of Surgeons last February. The Dermoid cysts are here considered from an evolutionist's point of view. The text is profusely illustrated.

SYLLABUS OF LECTURES IN ANATOMY AND PHYSIOLOGY. By T. B. Stowell, A.M., Ph.D. Third edition. 8vo, pp. 118. (Syracuse, N.Y.: C. W. Bardeen. 1889.)

The student of anatomy who follows out the directions here given will have much precision given to his enquiries, and will miss no point of importance that should be noticed in his course of reading and study. The pages are interleaved for the purpose of notes.

Joseph Rogers, M.D.: Reminiscences of a Workhouse Medical Officer. Edited with a Preface by Professor Thorold Rogers. 8vo, pp. xxv.—252. (London: T. Fisher Unwin. 1889.) Price 7s. 6d.

This is a record of labour among the poor, of perseverance in endeavouring to get rid of evils in our poor-law regulations and procedure, and of obstacles which had to be encountered before improvement could be effected. The narrative is told in earnest, simple language, which at once makes the reader interested in the subject, while the professional hindrances which were repeatedly in the way of good progress make clear to us the dimensions of the task which the author daily set himself to perform. As the editor says in his preface, "He was met by obstacles which would have daunted a less resolute man." The book is well bound and well printed.

The Unrivalled Atlas. (Edinburgh and London: W. & A. K. Johnston.) Price 3s. 6d.

This atlas is truly worthy of the title given to it, and surpasses any we have seen at the price. The size is 15 by 12 inches, so that there is no cramping of places, and everything seems to have been done to bring the maps up to the present state of geographical knowledge. Besides 33 full political maps, with an index to places with their latitude and longitude, there are also two classical maps with an index, two physical maps, and two astronomical plates, accompanied by descriptive letterpress. The work is strongly bound in cloth and is entitled to all praise.

John Heywood's National Atlas. (Manchester and London: John Heywood.)

This atlas contains 32 maps, with an alphabetical index, giving the situation, latitude, and longitude of all the places of importance throughout the world. The distance from the chief ports of the British Isles to those of the Continent are given, and we notice that latest information as to geographical news is also embodied. The enlarged maps of Cape Colony and the Dominion of Canada will be found very useful to pupils in their study of our British possessions.

Principles of Book-Keeping. By the Rev. C. N. Nagel, M.A., and Alexander Hall. Post 8vo, pp. viii.—118. (London: Relfe Brothers. 1889.)

The Authors, who state in the preface that they have had twenty-five years in the teaching of the principles here laid down, assert that pupils who have gone through the course as here mapped out for them, and have worked through the progressive examples here given, will have very great facility in understanding the principles underlying the various systems in use in business houses. So far as we can see the statements are accurate, and such success would most likely attend the pupil's efforts.

Solutions of the Examination Papers in Algebra, Mensuration, and the Theory and Use of Logarithms, set for entrance to the Royal Military College, Sandhurst, from July, 1880, to December, 1888, inclusive. By the Rev. John H. Robson, M.A., LL.D. Post 8vo, pp. 149. (London: Relfe Brothers.)

Accompanying the solutions, and in a separate book, enclosed in pocket of cover, are the papers as originally set. The book is specially useful to students preparing for Sandhurst, London, and Cambridge University, and the College of Preceptors' Examinations.

Relfe Bros. School & College Examination Arithmetic. By John Bowick, B.A., LL.D. pp. 367. (London: Relfe Bros.)

This is a well-printed Arithmetic, with very distinct figures and very clearly-put arguments and illustrations. Special attention has been given to Commercial Arithmetic, and the questions and problems have been made as practical as possible. There is also a good collection of Examination Papers, with model solutions, taken from the College of Preceptors', the Oxford and Cambridge, and London University Examinations. A few pages are devoted to contracted approximate methods. The chapters on Partnership, Percentages, Profit and Loss, Interest, Discount, and the Metric System contain more information on matters than most school-books.

Nouvelles Tables de Logarithmes : à cinq et à quatre décimales, pour les lignes trigonométriques, dans les deux systèmes de la division centésimale et de la division sexagésimale du quadrant, et pour les nombres de 1 à 12,000. Royal 8vo. (Paris: Libraire, Gauthier-Villars et Fils. 1889.) Price 4fr.

This elaborate work is one of the cheapest of the Tables of Logarithms that we know of, and will be found specially serviceable to Surveyors, Students of Astronomy, and others engaged or interested in Mathematical calculations.

The Epping Hunt. By Thomas Hood. pp. 43. (Glasgow: David Bryce and Son. 1889.)

A Reproduction of this famous poem, with six engravings on wood after the designs of George Cruikshank.

Putt's Notions. By Mrs. Charles Hervey. Crown 8vo, pp. viii.—247. (London: Jarrold and Sons. 1889.)

The Title strikes us as curious, but in an apology the Author states that "Putt" was a name bestowed upon her in earliest infancy, and the giver of it even foreshadowed a work that should embrace that name. The notions are to be gathered from five stories: The Gardener's, the School Girl's, the Young Man's, the Widow's, Somebody Else's.

Our Fancy Pigeons, and Rambling Notes of a Naturalist. By George Ure. Royal 8vo, pp. xvi.—288. (London: Eliot Stock. 1889.)

This is a record of fifty years' experience in breeding and in observation of nature. The chapters devoted to pigeons take up the greater part of the work, and supply some helpful matter for pigeon fanciers and breeders. The notes upon our common song-birds will be read with interest by ornithologists.

The Life & Work of Emin Pasha in Equatorial Africa. By the Rev. Henry W. Little. With Portrait and Map. Foolscap 4to, pp. 112. (London: J. S. Virtue & Co. 1889.)

The Author has done a good thing in bringing together particulars of the great Pasha's mission, and in recounting the evidences of "One Man's Power." The pleasing and forcible style of the writing adds to the charm of the book, for while the subject is grand the reader feels that it is being handled by one who is in deep interest and sympathy with the hero, and well informed in all the details required to make a useful and concise history of Dr. Emin's doings in Equatorial Africa.

Bird-Preachers: Friendly Talks with Little Folks about Bible Birds. By Rev. A. N. Mackray, M.A. 12mo, pp. 128. (London: The Religious Tract Society.) Price 1s.

The substance of these Friendly Talks formed the Children's Portion in the Sunday Morning Service which the Author constructed in the ordinary course of his ministry. There are several nice illustrations.

Three Lectures on English Literature. By W. S. M'Cormick, M.A. (Paisley: Alexander Gardener.) pp. 184.

The Lectures formed part of a series on "The English Poets of the Nineteenth Century," delivered to the Students in Glasgow University during the Session of 1887—88. They deal respectively with "English Literature and University Education," "The Poetry of William Wordsworth," "The Poetry of Robert Browning." The Author has dealt with his topics in an exhaustive way and throws considerable light on the works of these two poets by his suggestions and criticisms.

The Salt-Cellars: Being a Collection of Proverbs with Homely Notes thereon. By C. H. Spurgeon. Vol. I., A. to L. Crown 8vo, pp. viii.—334. (London: Passmore and Alabaster. 1889.)

The Author has for many years published an almanac containing a proverb for every day, and in order that the public may have these in a compact form he has produced this, the first volume of the series, with notes showing the application of the wise sayings to the common doings of life. His remarks are truly characteristic in their terseness of expression.

The Bibles of England: a Plain Account for Plain People of the Principal Versions in English. By Andrew Edgar, D.D. pp. i.—xi., 1.—403. (Paisley and London: Alexander Gardner.)

This well-written and nicely got-up volume will be of special service to many who are desirous of having a concise History of our English Bibles not overburdened by classical allusions and quotations. The writer's style is such as will carry the reader on with interest through the different chapters, each of which is preceded by an analysis that helps very materially in the remembering of the most important items. There is also an appendix containing, among other articles, one on the Theocracy Established by Calvin at Geneva.

A Complete Guide to the Improvement of the Memory; or, the Science of Memory Simplified, with practical applications to Language, History, etc. By the Rev. J. H. Bacon. (London: I. Pitman and Sons.) pp. 136.

This is a very valuable little work, inasmuch as it takes the reader through a course of treatment for the Memory, which if fully acted upon cannot fail to bring much additional pleasure to one's profitable reading of books, and to strengthen the power of retentiveness, which in modern education receives so little scientific attention. The applications of the system to every-day work are shown, and hints given for the rapid learning of languages, etc.

Short Essays: Original and Selected. Fourth edition. 12mo, pp. 195. (London: Moffatt and Paige. 1889.) Price 2s. 6d.

These Essays are for the purpose of assisting young students in writing Themes, as a preparation for the Oxford and Cambridge, Civil Service, Scholarship, Certificate, and other Exams. They contain specimens of letters by the best English writers, Introductory chapters on English Composition, a copious list of subjects for Exercises, and a collection of Faulty Expressions to be avoided.

ORIGINAL ENGLISH, as written by Little Ones at School. By Henry J. Barker, B.A., F.R.S.L. 12mo, pp. 161. (London: Jarrold and Sons. 1889.) Price 1s.

Here are some amusing examples of Juvenile Composition, a few of which appeared in *Longman's Magazine*, under the title of "Studies of Elementary School Life," and were so well received, that a more complete form was called for. The book has now reached a fourth edition.

A WEEK ON THE CONCORD AND MERRIMAC RIVERS. By Henry Thoreau; with a Prefatory Note by Will H. Dircks. Post 8vo. pp. 349. (London: Walter Scott.)

In the prefatory note it is said that "The Author preached many sermons and taught many lessons; their significance is best to be discerned in his own writings." His peculiar style and his ruling principles of life may be gleaned from this interesting record of a week. This is one of the Camelot series.

GRAMMAR-LAND; or, Grammar in Fun for the Children of Schoolroomshire. By N. L. Nesbitt. Fourth Edition. Royal 16mo, pp. viii.—124. (London: Houlston and Sons. 1889.) Price 2s.

The book is dedicated to little children, who think grammar hard and dry. It is undoubtedly a subject looked upon by young minds as a weary toil to no purpose. Such a way of treatment as here set forth has produced good results, and, from the reception the book has already had, we believe the demand for it will continue to increase.

THE CENTURY DICTIONARY.—We have pleasure in acknowledging the receipt of the Prospectus of this dictionary, Part I. of which is just published by Mr. T. Fisher Unwin. It is to be completed in 24 monthly parts, price 10s. 6d. each.

STUDIES IN THE OUTLYING FIELDS OF PSYCHIC SCIENCE. By Hudson Tuttle. Crown 8vo, p. 250. (New York: M. L. Holbrook and Co.)

The first three chapters of these studies contain discussions on Matter, Life, and Spirit, and the subsequent chapters with the Mesmeric, Sonnambulic, and Clairvoyant states. Many curious incidents are related, on evidently reliable authority, all bearing upon these slightly-understood phenomena, and there is little doubt but that from such publications as these, where the facts are placed together in some more scientific order than has hitherto been done, we shall be in a fair way of advancing our knowledge of the mind's action.

THE ILLUSTRATED GUIDE TO FELIXSTOWE AND NEIGHBOURHOOD, including a trip down the Orwell to Harwich. By Dr. J. E. Taylor, F.L.S., F.G.S., etc. Second edition. 12mo, pp. 102. (London and Norwich: Jarrold and Sons. 1889.)

This Guide contains much information interesting to visitors concerning the Antiquities, Stones, Fossils, and Natural History of the district.

THE VALE OF LLANGOLLEN and the Course of the Dee. By Ralph Darlington. Post 8vo, pp. 68. (Llangollen: R. Darlington. London: W. J. Adams and Sons. 1889.) Price 1s.

The chief routes in this beautiful district, with their points of interest, are detailed, embracing Chester, Wrexham, Ruabon, Corwen, and Bala. There are thirty illustrations and contributions from distinguished writers.

SUMMER IN BROADLAND: Gipsying in East Anglian Waters. By the author of Friesland Meres, etc. Post 8vo, pp. 136. (London: Jarrold and Sons. 1889.) Price 1s.

This is one of the Holiday Series, and in eight chapters gives some noteworthy features to be met with on the Broads, accompanied by sketches of the most important points of interest *en route.*

ON FOOT THROUGH THE PEAK; or, A Summer Saunter through the Hills and Dales of Derbyshire. By James Croston, F.S.A. Ninth edition. Crown 8vo, pp. xiv.—350. (London and Manchester: John Heywood. 1889.) Price 3s. 6d.

Many editions of this work have been called for. In the present one the author has brought his information well up to date and made other improvements, which add to the completeness of the narrative. A very useful Itinerary is appended, which will render great help to the tourist; and we must also mention a Catalogue of Mosses and Ferns found in the neighbourhood of Castleton as being of special interest to the naturalist. The illustrations, taken from photographs, have been done specially for this edition.

GUY'S SOUTH OF IRELAND PICTORIAL GUIDE. 8vo, pp. xxvii.—112. (Cork: Guy and Co., Limited. London: Simpkin, Marshall, and Co.)

The illustrations accompanying the letterpress are very numerous and interesting. Maps of the districts usually visited by tourists also afford much help to travellers who carry their guides in the pocket.

THE WORKS OF HUBERT HOWE BANCROFT. Vol. XXXVI., Popular Tribunals (Vol. I.). pp. 1.—xiii., 1—749. (London: Trübner and Co. San Francisco: The History Company. 1887.)

The writer of this work is pre-eminently an historian, but here he treats us with a consideration of those ethical principles which underlie all history and upon which he is so competent to offer judgment, owing to the enormous amount of material he has at command and the keen insight into the motives of the individuals and parties whom he has studied in the preparation of his various works. While the reader is allowed much latitude for the exercise of his own opinion, the author fearlessly places before him his conclusions, which throughout maintain a tone of manliness and honesty that must find an echo in all who have the welfare of society at heart. Like all the previous volumes of this series, the get-up is admirable.

TALES FROM BLACKWOOD. Third series, No. 4.

TRAVEL, ADVENTURE, AND SPORT. Third series, No. 4. (Edinburgh and London: Wm. Blackwood and Sons. 1889.) Price 1s. each.

These books, in alternate months, contain a selection from the numerous papers which have appeared in the magazine from the commencement down to the present time. The selections are carefully made, afford some good reading, and are very handy in size.

PRACTICAL AMATEUR PHOTOGRAPHY. By C. C. Vevers. Revised and Enlarged. Post 8vo, pp. 60. (Leeds: C. C. Vevers. 1889.) Price 6d.

This is a new edition of this useful little work, affording the Amateur much valuable information.

THE INTERNATIONAL ANNUAL OF ANTHONY'S PHOTOGRAPHIC BULLETIN. Edited by W. Jerome Harrison, F.G.S., and A. H. Elliott, Ph.D., F.C.S. Crown 8vo, pp. 479. (New York: E. & H. T. Anthony; London: Illiffe and Son.)

The annual for last year was so well received, that the editors felt themselves fully justified in bringing out another volume for the present year. Everything has been done by them to make the illustrations of photography as perfect as possible, and it really forms a most handy and useful resumé of photographic progress.

TRAITE PRATIQUE DU DEVELOPPEMENT: Étude raisonée des divers révélateurs et de leur mode d'emploi. Par Albert Londe. Price 2fr. 75c.

LE DEVELOPPEMENT DE L'IMAGE LATENTE. Par A. de la Baume Pluvinel. Price 2fr. 75c.

LE CYLINDROGRAPHE APPAREIL PANORAMIQUE. Par P. Moëssard. Second Partie: Le Cylindrographe Topographique. Price 1fr. 75c.

LE CYLINDROGRAPHE APPAREIL PANORAMIQUE. Par E. Moëssard. Première Partie: Le Cylindrographe Photographique. Price 1fr. 75c. (Paris: Gauthier-Villars et Fils. 1889.)

The latest particulars of the different branches of Photography embraced in the titles of these further volumes of the Photographic Library will be of service to all practising the art.

RURAL RAMBLES: The Herts Border. By H. J. Foley. Post 8vo, pp. xii.—110. Price 1s.

OUR LANES AND MEADOW-PATHS; or, Rambles in Rural Middlesex. By H. J. Foley. Post 8vo, pp. xii.—114. (London: Truelove and Shirley. 1887.) Price 1s.

The former of these serves as a guide to the neighbouring walks of London; the latter goes a little further afield. Both have maps showing the best routes and illustrations of objects to be met with on the way.

HOLIDAY JOURNEYS IN NORTHAMPTONSHIRE. By J. Alfred Gotch. 8vo, pp. 34. (Northampton: Taylor and Son. 1889.) Price 2s.

The illustrations of the notable buildings in the county form the chief feature of this book, which is one of a series of similar handbooks brought out by Messrs. Taylor and Son.

ANNUAIRE DE L'OBSERVATOIRE MUNICIPAL DE MONTSOURIS pour l'an 1889: Meteorologie, Chimie, Micrographie, Applications a l'Hygiene. (Paris: Gauthier-Villars.)

The meteorological and other work done at the Montsouris observatory is here recounted, the working of the institution being under the auspices of the Municipality of Paris. The articles on organisms found in dust, air, and water are of special interest to microscopists, and occupy a considerable space in the book.

GOSSIPING GUIDE TO WALES (North Wales and Aberystwyth). 12mo, pp. lxxxviii.—324. (London: Simpkin, Marshall, and Co. 1889.) Price 3s. 6d.

This aims to be a practical, convenient, and complete handbook. It contains a list of the chief Hotels, with thirty-four maps, plans, etc.; also a large amount of Botanical, Geological, and Natural History information. There is a useful glossary of Welsh terms.

Part 2 (July) of the CARMARTHENSHIRE NOTES. Edited by Arthur Mee, F.R.A.S. Contains several articles, Antiquarian, Topographical, and Curious, relating to Members of Parliament, Pioneers of Trade, etc., connected with this particular district. It is published at the *South Wales Press* Offices, Llanelly. Annual subscription, 2s.

FUNDAMENTAL PRINCIPLES OF EDUCATION: Lectures delivered to Sunday School Teachers, by Rev. H. Kingsmill Moore, M.A. 16mo, pp. 80. (London: Church of England Sunday School Institute. 1889.) Price 6d.

The reception accorded to a similar volume last year has encouraged the author to publish a second of the series.

GLEANINGS FROM MANY SHEAVES. 24mo, pp. 152. (London: Bemrose and Sons. 1889.)

This is a collection of 640 sentences, each bearing an expressive meaning.

THE SMOKER'S TEXT-BOOK. By J. Hamer, F.R.S.L. Crown 8vo, pp. 54. (Liverpool: Office of *Cope's Tobacco Plant.* 1889.)

Herein are some witty pieces, all affording amusement and sometimes instruction to the admirers of the weed.

ILLUSTRATIONS, Mr. Francis George Heath's Magazine of Amusement, Art, Biography, Economy, Invention, Literature, and Science, will commence its fifth volume in October with a new pictorial cover, and its forthcoming issues will include, besides fiction, illustrated papers, embracing drawings of the month, reproductions of National Gallery pictures, pretty places, art studies, eminent artists, pen-and-pencil portraits of celebrities, public and private schools, Tyrolese winter resorts, popular flowers, farm-gossip, and miscellaneous "sketches" of men, things, places, art, literature, and science. *Illustrations* will be published by the firm about to amalgamate as Simpkin, Marshall, Hamilton, Kent, and Co.

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